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THE R&D/MARKETING INTERFACE IN PRODUCT INNOVATION

- A Case of the UK Pharmaceutical Industry

By

Qing Wang

SUBMITTED FOR THE QUALIFICATION OF DOCTOR OF PHILOSOPHY

WARWICK BUSINESS SCHOOL

UNIVERSITY OF WARWICK

AUGUST 1993

ABSTRACT

This R&D/marketing interface study is of a multi-disciplinary nature. In the study the role of the R&D/marketing interface is regarded as the pursuit of competitive advantage through negotiated exchange process between the two parties. As a result, important research constructs are identified with reference to several academic disciplines, including organization theory, innovation studies, marketing and strategic management. These constructs are (a) the environmental constructs, (b) the organizational constructs, and (c) the strategic constructs.

A case study methodology is applied to examine the R&D/marketing interface patterns and tendencies found in twelve drug innovation projects. However, the research theoretical framework is not constrained to a particular industry. Thus, on the basis of the framework, the study aims to offer a higher level explanation on why these variations and tendencies regarding the R&D/marketing interface have been observed.

The research findings indicate that the twelve drug innovation projects studied in this research belong to three project types. These include a "related-technology and existing-market" type of project, an "unrelated-technology and new-market" type of project and a "new-technology and new-market" type of project. The research findings further reveal that the effectiveness and the desired level of the R&D/marketing interface are influenced by both the environmental constructs and the organizational constructs. Meanwhile, several unexpected findings are derived from the research, such as the serious effect of contingent technical problems upon the R&D/marketing interface, the crucial balance between development speed and development risk and so on.

The research has resulted in a more precise definition of the R&D/marketing interface in five dimensions. These are (a) the corporate strategic dimension, (b) the corporate technical dimension, (c) the product strategic dimension, (d) the product technical dimension and (e) the operational dimension. These dimensions form an integral part of the R&D/marketing interface. This finding will provide the future research in this field with a crucial link to those academic areas indicated earlier. It will also help top management, marketing managers and R&D managers identify more accurately their responsibilities and detect quickly the weak interface dimensions that need to be strengthened.

TABLE OF CONTENTS

	Page
LIST OF TABLES	VIII
LIST OF FIGURES	XII
ACKNOWLEDGEMENT	XIII
DECLARATION	XV
<u>INTRODUCTION</u>	1
I. Research Background.....	1
II. Organization of the Thesis.....	4
III. Summery of the Important Research Findings.....	6
<u>CHAPTER 1: LITERATURE REVIEW</u>	8
1.1 INTRODUCTION	8
1.2 THE EXISTING THEORETICAL AND EMPIRICAL STUDIES IN THE R&D/MARKETING INTERFACE	9
1.2.1 Organization Theory on Relationships.....	9
1.2.2 The R&D/Marketing Interface in Product Innovation.....	11
1.2.3 Studies Towards an Integration of Organization Theory and Innovation Research.....	14
1.2.4 Common R&D/Marketing Interface Problems and Limitations of the Existing Research.....	15
1.3 A BROADER REVIEW ON ORGANIZATIONAL PERSPECTIVES	17
1.3.1 Interdependence and Coordination.....	17
1.3.2 Differentiation and Integration.....	18
1.3.3 Relative Influence of the Functional Departments and Organizational Uncertainty.....	18
1.3.4 Summary.....	19
1.4 A BROADER REVIEW ON INNOVATION STUDIES	20
1.4.1 Types and Stages of Product Innovation.....	21
1.4.2 R&D Management.....	24
1.4.3 The Core Technological Competence of the Firm.....	25
1.4.4 Summary.....	27
1.5 A BROADER REVIEW ON MARKETING PERSPECTIVES	28
1.5.1 The Strategic Marketing.....	29

1.5.2 High Technology Marketing.....	31
1.5.3 Marketing Research for Product Innovation.....	32
1.5.4 Summary.....	34
1.6 CONCLUSION.....	35

<u>CHAPTER 2: RESEARCH METHODOLOGY.....</u>	38
2.1 INTRODUCTION.....	38
2.2 THE PILOT STUDY.....	39
2.2.1 The Objectives of the Pilot Study.....	39
2.2.2 The Processes of the Pilot Study	40
2.2.3 The Outcome of the Pilot Study	41
2.3 CASE STUDY METHODOLOGY.....	42
2.3.1 Specific Research Objectives.....	42
2.3.2 Case Study Strategy.....	43
2.4 THE RESEARCH POPULATION AND RESEARCH SAMPLE.....	44
2.4.1 The Research Population.....	44
2.4.2 The Research Sample.....	46
2.5 DATA COLLECTION.....	47
2.5.1 Reliability of the Data.....	47
2.5.2 Data Collection.....	49
2.6 DATA ANALYSIS.....	50
2.6.1 The Relationship Between the Theoretical Framework and the Data Analysis.....	50
2.6.2 The Adoption of Checklist Models for Assessing the Environmental Constructs.....	51

<u>CHAPTER 3: THE RESEARCH THEORETICAL FRAMEWORK.....</u>	55
3.1 INTRODUCTION.....	55
3.2 RESEARCH QUESTIONS.....	56
3.3 RESEARCH CONSTRUCTS.....	56
3.3.1 Organizational Constructs.....	57
3.3.2 Strategic Constructs.....	59
3.3.3 Environmental Constructs.....	60
3.3.4 Type of Innovation Project.....	61
3.4 RESEARCH PROPOSITIONS.....	62

3.5 MEASUREMENT OF THE RESEARCH CONSTRUCTS IN RELATION TO THE PHARMACEUTICAL INDUSTRY.....	63
3.5.1 Adjustment of the Environmental Constructs to the Pharmaceutical Industry.....	64
3.5.2 Measurement of the Environmental Constructs Using Checklist Models.....	66
3.5.3 Measurement of the Drug Innovation Performance....	67
3.6 SUMMARY.....	69
 <u>CHAPTER 4: THE PHARMACEUTICAL INDUSTRY BACKGROUND.....</u>	 72
4.1 INTRODUCTION.....	72
4.2 GOVERNMENT REGULATION AND PATENT LAW.....	73
4.2.1 Government Regulation.....	73
4.2.2 Patent Law.....	74
4.3 MARKET STRUCTURE AND COMPETITION.....	76
4.3.1 Market Structure.....	76
4.3.2 Competition.....	78
4.4 PHARMACEUTICAL INNOVATION AND RISK AND RETURN IN PHARMACEUTICAL R&D.....	79
4.4.1 Pharmaceutical Technology.....	79
4.4.2 Pharmaceutical Innovation and Risk and Return in Pharmaceutical R&D.....	80
4.5 THE R&D/MARKETING INTERFACE IN THE PHARMACEUTICAL INDUSTRY.....	83
4.6 THE U.K PHARMACEUTICAL INDUSTRY.....	84
 <u>INTRODUCTION TO THE CASE STUDIES.....</u>	 90
 <u>CHAPTER 5 THE GALXO CASE.....</u>	 92
5.1. INTRODUCTION.....	92
5.2. THE R&D/MARKETING INTERFACE IN DEVELOPING ZANTAC... 	96
5.2.1 Environmental Constructs.....	96
5.2.2 Strategic Constructs.....	98
5.2.3 Organizational Constructs.....	100
5.2.4 The Innovation Performance.....	102

5.2.5 Summary.....	103
5.3 THE R&D/MARKETING INTERFACE IN DEVELOPING IMIGRAN.	106
5.3.1 Environmental Constructs.....	106
5.3.2 Strategic Constructs.....	107
5.3.3 Organizational Constructs.....	109
5.3.4 The Innovation Performance.....	110
5.3.5 Summary.....	111
5.4. THE R&D/MARKETING INTERFACE IN DEVELOPING	
SEREVENT.....	113
5.4.1 Environmental Constructs.....	113
5.4.2 Strategic Constructs.....	115
5.4.3 Organizational Constructs.....	116
5.4.4 The Innovation Performance.....	117
5.4.5 Summary.....	118
5.5 FINAL ANALYSIS.....	121
 <u>CHAPTER 6 SMITHKLINE BEECHAM CASE.....</u>	 124
6.1. INTRODUCTION.....	124
6.2. THE R&D/MARKETING INTERFACE IN DEVELOPING TAGAMET.	127
6.2.1 Environmental Constructs.....	127
6.2.2 Strategic Constructs.....	129
6.2.3 Organizational Constructs.....	130
6.2.4 The Innovation Performance.....	131
6.2.5 Summary.....	132
6.3 THE R&D/MARKETING INTERFACE IN DEVELOPING	
AUGMENTIN.	134
6.3.1 Environmental Constructs.....	134
6.3.2 Strategic Constructs.....	136
6.3.3 Organizational Constructs.....	137
6.3.4 The Innovation Performance.....	139
6.3.5 Summary.....	139
6.4. THE R&D/MARKETING INTERFACE IN DEVELOPING EMINASE.	142
6.4.1 Environmental Constructs.....	142
6.4.2 Strategic Constructs.....	144
6.4.3 Organizational Constructs.....	145
6.4.4 The Innovation Performance.....	146

6.4.5 Summary.....	147
6.5 FINAL ANALYSIS.....	149
 <u>CHAPTER 7 ICI PHARMACEUTICALS CASE.....</u>	<u>151</u>
7.1. INTRODUCTION.....	151
7.2. THE R&D/MARKETING INTERFACE IN DEVELOPING	
 TENORMIN	154
7.2.1 Environmental Constructs.....	154
7.2.2 Strategic Constructs.....	156
7.2.3 Organizational Constructs.....	157
7.2.4 The Innovation Performance.....	158
7.2.5 Summary.....	159
7.3 THE R&D/MARKETING INTERFACE IN DEVELOPING DIPRIVAN.....	161
7.3.1 Environmental Constructs.....	161
7.3.2 Strategic Constructs.....	163
7.3.3 Organizational Constructs.....	164
7.3.4 The Innovation Performance.....	166
7.3.5 Summary.....	167
7.4. THE R&D/MARKETING INTERFACE IN DEVELOPING ZOLADEX.....	169
7.4.1 Environmental Constructs.....	169
7.4.2 Strategic Constructs.....	171
7.4.3 Organizational Constructs.....	173
7.4.4 The Innovation Performance.....	174
7.4.5 Summary.....	174
7.5 FINAL ANALYSIS.....	177
 <u>CHAPTER 8 THE WELLCOME.....</u>	<u>180</u>
8.1. INTRODUCTION.....	180
8.2. THE R&D/MARKETING INTERFACE IN DEVELOPING ZOVIRAX.....	185
8.2.1 Environmental Constructs.....	185
8.2.2 Strategic Constructs.....	187
8.2.3 Organizational Constructs.....	189
8.2.4 The Innovation Performance.....	191
8.2.5 Summary.....	191
8.3 THE R&D/MARKETING INTERFACE IN DEVELOPING RETROVIR.....	194
8.3.1 Environmental Constructs.....	194

8.3.2 Strategic Constructs.....	196
8.3.3 Organizational Constructs.....	198
8.3.4 The Innovation Performance.....	199
8.3.5 Summary.....	199
8.4. THE R&D/MARKETING INTERFACE IN DEVELOPING	
LAMICTAL	202
8.4.1 Environmental Constructs.....	202
8.4.2 Strategic Constructs.....	204
8.4.3 Organizational Constructs.....	205
8.4.4 The Innovation Performance.....	206
8.4.5 Summary.....	207
8.5 FINAL ANALYSIS.....	209
<u>CHAPTER 9 CROSS-CASE ANALYSIS, EMPIRICAL FINDINGS</u>	
<u>AND MANAGERIAL IMPLICATIONS.....</u>	<u>213</u>
9.1 INTRODUCTION.....	213
9.2 EMPIRICAL FINDINGS OF THE CURRENT RESEARCH IN RELATION	
TO THE RESEARCH QUESTIONS AND PROPOSITIONS.....	213
9.2.1 The Role of the R&D/Marketing Interface in Product	
Innovation.....	214
9.2.2 The Environmental Influence Upon the R&D/Marketing	
Interface.....	217
9.2.3 The Organizational Influence Upon the R&D/Marketing	
Interface.....	221
9.2.4 The Performance of The Drug Innovation Projects..	225
9.3 THEORETICAL AND MANAGERIAL IMPLICATIONS OF	
THE EMPIRICAL FINDINGS.....	227
9.3.1 The Combined Effect of the Environment and the	
Organization on the R&D/Marketing Interface.....	228
9.3.2 The Different Desired Level of the R&D/marketing	
Interface in Different Projects.....	228
9.3.3 The Effect of the External Environment on the	
Negotiated Exchange Process Within Organization..	229
9.3.4 Unexpected Findings of the Current Research.....	230
9.4 SUMMARY.....	232

<u>BIBLIOGRAPHY</u>	236
<u>APPENDIX 1</u> .Interviews of the Pilot Study.....	244
<u>APPENDIX 2</u> Interviews of the Four Case Studies.....	245
<u>APPENDIX 3</u> Cover Letter for the Interviews.....	247
<u>APPENDIX 4</u> Outline of the Research and Areas of the Interview.....	248
<u>APPENDIX 5</u> Letter Attached to One of the Case Study Reports Which Were Send Back to the Industry For Final Comment.....	250
<u>APPENDIX 6</u> Drug Company R&D Productivity, 1980-90.....	251
<u>APPENDIX 7</u> One of the Interview Transcripts.....	252
<u>APPENDIX 8</u> Company Letter.1.....	254
<u>APPENDIX 9</u> Company Letter 2.....	255

LIST OF TABLES

TABLE	PAGE
2.1	Top Ten High-Tech Industries Based on R&D Expenditure as a Percentage of Sales 40
2.2	The Choice of the Pharmaceutical Industry 45
2.3	The Selection of the Products 47
3.1	Measurement of the Market Uncertainty Using Checklists Method 66
3.2	Measurement of the Technological Uncertainty Using Checklists Method66
3.3	Measurement of Internal Technological and Marketing Strength Using Checklists Method67
3.4	The Innovative Levels of the New Pharmaceutical Products 68
4.1	Top 50 Branded Products Worldwide By Country of Origin85
4.2	Companies That Have Originated or Marketed More Than One 1990 Top-50 Branded Drugs 86
4.3	1990 World's Best-Selling Drugs87
4.4	Top Drug Companies in 199187
5.1	Principal Glaxo Discoveries 1964-199092
5.2	R&D Activities, Manpower and Spending in Different Stages of R&D Process.....94
5.3	Statistical Review of Glaxo Holding plc.95
5.4	Product Development Time Scales95
5.5	Product descriptions96
5.6	Assessment of the Environmental Constructs in the Zantac Project.....103
5.7	Assessment of the Strategic Constructs in the Zantac Project.....104
5.8	Assessment of the Organizational Constructs in the Zantac Project.....104
5.9	Assessment of the Innovation Performance104
5.10	Assessment of the Environmental Constructs in the Imigran Project.....111

5.11	Assessment of the Strategic Constructs in the Imigran Project.....	111
5.12	Assessment of the Organizational Constructs in the Imigran Project.....	111
5.13	Assessment of the Innovation Performance	112
5.14	Assessment of the Environmental Constructs in the Serevent Project.....	118
5.15	Assessment of the Strategic Constructs in the Serevent Project.....	119
5.16	Assessment of the Organizational Constructs in the Serevent Project.....	119
5.17	Assessment of the Innovation Performance	119
6.1	The New Lineup of Drug Giants.....	126
6.2	Product Descriptions	127
6.3	Assessment of the Environmental Constructs in the Tagamet Project.....	132
6.4	Assessment of the Strategic Constructs in the Tagamet Project.....	132
6.5	Assessment of the Organizational Constructs in the Tagamet Project.....	133
6.6	Assessment of the Innovation Performance	133
6.7	Assessment of the Environmental Constructs in the Augmentin Project.....	139
6.8	Assessment of the Strategic Constructs in the Augmentin Project.....	140
6.9	Assessment of the Organizational Constructs in the Augmentin Project.....	140
6.10	Assessment of the Innovation Performance	140
6.11	Assessment of the Environmental Constructs in the Eminase Project.....	147
6.12	Assessment of the Strategic Constructs in the Eminase Project.....	147
6.13	Assessment of the Organizational Constructs in the Eminase Project.....	147
6.14	Assessment of the Innovation Performance	148

7.1	Principal ICI Pharmaceuticals Discoveries 1963-1988	151
7.2	Product Development Time Scales	154
7.3	Product Descriptions	154
7.4	Assessment of the Environmental Constructs in the Tenormin Project.....	159
7.5	Assessment of the Strategic Constructs in the Tenormin Project.....	159
7.6	Assessment of the Organizational Constructs in the Tenormin Project.....	160
7.7	Assessment of the Innovation Performance	160
7.8	Assessment of the Environmental Constructs in the Diprivan Project.....	167
7.9	Assessment of the Strategic Constructs in the Diprivan Project.....	167
7.10	Assessment of the Organizational Constructs in the Diprivan Project.....	168
7.11	Assessment of the Innovation Performance	168
7.12	Assessment of the Environmental Constructs in the Zoladex Project.....	175
7.13	Assessment of the Strategic Constructs in the Zoladex Project.....	175
7.14	Assessment of the Organizational Constructs in the Zoladex Project.....	175
7.15	Assessment of the Innovation Performance	176
8.1	Principal Wellcome Discoveries 1968-1990	180
8.2	The Financial Highlights of Wellcome plc.	181
8.3	Product Development Time Scales	184
8.4	Product Descriptions	184
8.5	Assessment of the Environmental Constructs in the Zovirax Project.....	192
8.6	Assessment of the Strategic Constructs in the Zovirax Project.....	192
8.7	Assessment of the Organizational Constructs in the Zovirax Project.....	192
8.8	Assessment of the Innovation Performance	193

8.9	New Competition for AZT	195
8.10	Assessment of the Environmental Constructs in the Retrovir Project.....	199
8.11	Assessment of the Strategic Constructs in the Retrovir Project.....	200
8.12	Assessment of the Organizational Constructs in the Retrovir Project.....	200
8.13	Assessment of the Innovation Performance	200
8.14	Assessment of the Environmental Constructs in the Lamictal Project.....	207
8.15	Assessment of the Strategic Constructs in the Lamictal Project.....	208
8.16	Assessment of the Organizational Constructs in the Lamictal Project.....	208
8.17	Assessment of the Innovation Performance	208
9.1	The Role of the R&D/Marketing Interface in Drug Innovation.....	215
9.2	Types of the Drug Innovation Projects	219
9.3	The Status of the R&D/Marketing Interface Exchange Process	222
9.4	The Performance of the Drug Innovations	226

LIST OF FIGURES

FIGURE		PAGE
1.1	The Technology-Market Dimension Matrix	22
2.1	An Example of Checklist Model.....	52
2 2	A Project Selection and Evaluation System	53
3.1	Five Dimensions of the R&D/Marketing Interface.	60
4.1	The Comparison of Cost Structure Between Drug Innovators and Drug Imitators	75
4.2	The Time-Scale of New Drug Research and Development.....	81
5.1	Glaxo Business Structure	93
5.2	The Structure of Marketing Development Division	94
6.1	The Company Structure of SmithKline Beecham ..	124
6.2	Product Development Time Scale	126
7.1	The New Structure of the Development Department.....	152
7.2	The Structure of the Product Strategy Department	153
7.3	The Formal Corporate Interface Mechanism	165
8.1	Research, Development and Medical (RD&M) Structure	182
8.2	Group Marketing Structure	183
8.3	Review of the Anti-herpes Therapeutic Area ...	189

ACKNOWLEDGEMENT

While studying the management of innovative projects - the main theme of this doctoral research, the author has gained first hand experience in managing innovative project. To a certain extent doctoral research itself is an innovative project, and has shared a set of characteristics found in innovative projects regardless of type (Kanter, 1989):

- (a) The need to move quickly when opportunity or inspiration strikes.
- (b) Missed deadlines and encounters with the unexpected.
- (c) The constant need to justify the project, especially as new options come up.
- (d) Extreme emotional swings: numerous frustrations and moments of despair coupled with clear highs.

In addition, the author has also encountered difficulties in her life in this country that is completely new to her. Therefore, apart from people who have offered their great help in the academic work, this acknowledgement is also addressed to those who have motivated and encouraged her during this difficult period.

The author shall first thank the British Council for providing her with a TC Scholarship and the opportunity of attending international conferences. She is also indebted to the Chinese government which has supported her generously during the study.

Next, the author would like to express her great gratitude to her supervisor Mel Hirst who has constantly provided her with his support, encouragement and guidance. His positive and assuring attitude on her ability to succeed in the Ph.D has been most critical in building up her confidence.

In addition, the author would like to express her deep appreciation to Richard Whittington who has offered valuable advice in an impressively gentle and friendly manner and to Paul Stoneman who has kindly provided her with the opportunity to present the work in the Warwick Business School Seminar and to publish it in the School Research Paper series.

Her husband, Chungao Lu, has rendered his full support, love and assurance to her throughout the process, even at a time when his own career was confronted with major difficulties. He has made it possible for her to fulfil the dual responsibility of completing her doctoral research while at the same time mothering her child who was born during her Ph.D study.

Her parents' enthusiasm and determination in pursuing their own academic careers have had a profound influence on her life. Their devoted love and unfailing encouragement have been the major motivator behind every progress of hers.

There are so many people to whom she owes a great deal who have offered their generous help at different stages of the research process. The author would like to express her particular thanks to the people in the pharmaceutical industry who have offered their most precious cooperation and made the study of this extremely secretive industry possible. In addition, a number of her previous fellow Ph.D students at the Warwick Business School and her present colleagues at the Liverpool John Moores University, including David Lockwood, Brian Mase, Sue Bridgewater, Peter Smeaton and Jeremy Greenough, have all offered their help during the finalization of this thesis.

DECLARATION

No part of this thesis has been submitted in support of an application for another degree or qualification from this university or any other Institute of Learning.

Funding for the research was received from the British Council 1988 Technology Cooperation (TC) Scholarship.

The following papers have been published or presented as a result of the research:

1. "The Reliability of Using Interview Method in Case Study Data Collection", Paper for the *Dotoral Seminar on Advanced Research Methodologies in Technology Management*, organized by the European Institute of Advanced Studies in Management (EIASM), Netherlands, 18-21, May, 1992.
2. "The R&D/Marketing Interface in the Pharmaceutical Industry", Paper for the *Second Workshop on the Pharmaceutical Industry: Public and Private Players*, organized by the European Institute of Advanced Studies in Management (EIASM), Brussels, 7-9, September, 1992.
3. "The Interface of R&D and Strategic Marketing in Drug Innovation - A Case of the UK Pharmaceutical Industry", *Warwick Business School Working Paper*, November, 1992, No. 56, ISSN 0265-5976.
4. "The R&D/Marketing Interface in Product Innovation in the Modern Corporations", Paper for the *Symposium of Promoting Economic Development Through Advancement in Science and Technology*, organized by the Chinese Academy of Sciences, Shenzhen, 16-21, December, 1992.

INTRODUCTION

I. Research Background

The interface of R&D and marketing refers to the area between the R&D and marketing departments in which they affect or have links with each other. The term "interface" is sometimes interchangeable with "interaction", "relationship", "linkage" or "cooperation". The R&D/marketing interface is further divided into five dimensions in the current research.

Numerous studies have identified the R&D/marketing interface as an important determinant of successful product innovation. In addition, previous research has exploited, theoretically as well as normatively effective ways of managing the R&D/marketing interface.

However, most existing studies on the R&D/marketing interface have been limited to a single field such as organization studies or innovation research, which emphasises either the internal factors affecting the interface or the external influence upon the interface activities at particular innovation stages. In addition, these studies have focused only at one level of the interface problems, either relating to the efficacy of structural linkages for achieving better corporate performance (Horwitch and Thietart, 1987) or concerning the effectiveness of functional integration for successful product innovation. Consequently, little has been known about the synthetic process of the R&D/marketing interface influenced by both internal and external factors.

A pilot study has been carried out before defining the more specific research objectives and the research population. Ten British firms from several high-tech industrial sectors are investigated and important preliminary findings are generated. These include (a) the further diversification of the R&D and marketing departments according to their responsibilities relating to the stages of the product development process, (b) the internationalization of the high-tech firms, especially in the pharmaceutical industry, which has resulted in an increased importance of the strategic marketing and (c) the considerable variation of the R&D/marketing interface with regard to its roles and effectiveness. A further investigation on factors affecting the R&D/marketing interface and the underlying reasons are thus needed.

The current research is therefore designed to (a) investigate empirically the role of the R&D/marketing interface in product innovation and (b) offer theoretical explanation of the tendencies and variations of the R&D/marketing interface in relation to the market, technological and organizational environment. According to the research objectives, three groups of constructs are identified from the literature. They are the organizational constructs, the strategic constructs and the environmental constructs. The organizational constructs are identified as (a) type of the interface coordination mechanism, (b) interface communication flows, (c) interface conflict and (d) relative influence of R&D and marketing.

Meanwhile, the strategic constructs are related to the strategic role of the R&D/marketing interface in product innovation. Five dimensions are identified in the interface. They are (a) the corporate strategic dimension, (b) the corporate technical dimension, (c) the product strategic dimension, (d) the product technical dimension and (e) the operational dimension. These five dimensions of the interface are interrelated and they together fulfil the strategic role of the R&D/marketing interface, which is the pursuit of the firm's competitive advantage.

The environmental constructs are designed to reflect both external market and technological uncertainties facing product innovation and internal marketing and technological strength. These constructs include (a) market uncertainty, (b) technological uncertainty, (c) internal technological and marketing expertise. In addition, Six types of innovation projects have been categorized by using a "technology-market dimension" matrix.

The identification of the three groups of constructs reflects the emphasis of the current research on the evaluation of the impact of a series of process activities, technological factors and market factors on the eventual outcome. Three research propositions are developed, addressing respectively the role of the R&D/marketing interface, the environmental influence on this role and the effect of organizational factors upon the role fulfilment. The early development of the theoretical propositions is helpful in guiding data collection and data analysis with a theoretical orientation. However, it is important to recognize that they are only tentative. Therefore, in order to avoid any unnecessary data elimination, the theoretical propositions are developed in such a way that they

remain at a relatively general and abstract level, thus allowing further elaboration in the final cross-case analysis.

Case study strategy is decided to be most appropriate for the current research. This is because this strategy has a distinct advantage in a situation where a "how" or "why" question is being asked about a contemporary set of events over which the investor has little or no control (Yin, 1984). In addition, it focuses on understanding the dynamics present within single settings (Eisenhardt, 1989). In the current research, the case studies are used to describe the R&D/marketing interface patterns in product innovation and to further generate theoretical explanation regarding these patterns.

The UK pharmaceutical industry is selected as the research population from which a research sample of four innovative pharmaceutical firms, each involving three drug innovation projects, is drawn. The four pharmaceutical firms are Glaxo, SmithKline Beecham, ICI Pharmaceuticals and Wellcome. The total of twelve drug innovation projects are the Zantac project, the Imigran project, the Serevent project, the Tagamet project, the Augmentin project, the Eminase project, the Tenormin project, the Diprivan project, the Zoladex project, the Zevirax project, the Retrovir project and the Lamictal project. The research sample is selected for theoretical rather than statistical reasons. It is chosen to replicate previous cases, extend emergent theory and provide examples of polar types (Eisenhardt, 1989). It is necessary to note that in order to avoid bias in data collection, decisions on product sample selection were made independently according to predesignated criteria. Companies did not exert influence during this process. The UK pharmaceutical industry shares several common characteristics with other high-tech industrial sectors, such as high complexity of product development and environment, high competitiveness on the basis of technological innovation and high R&D expenditure. Meanwhile it has a few unique characteristics including high risk in the R&D investment and highly effective product differentiation as a entry barrier. Moreover, the UK industry is one of the few industries in which Britain is a genuine leader, and its innovation performance is a major successful factor. Thirteen out of the world's top fifty prescription products were developed by the UK pharmaceutical firms in 1990, which is only second to the US. An understanding of the industry's problems and achievements and especially of its

innovation in some of the leading innovative firms would be instructive for many of us both outside and inside the industry (Freeman, 1968).

As a result of this population selection, findings from the current research will not be generated directly to other industries. Nevertheless, it is important to note that the design of the research theoretical framework is not constrained to a particular industry, in terms of the research questions posed and the research constructs identified. Therefore, with certain adjustment on the measurements of some constructs, the research framework should be applicable to other industries.

In the current research, special effort has been made to ensure the reliability of the data. Multiple data collection methods including archives, statistic data from industry reports, stock broker reports, face-to-face and telephone interviews, field observation and participation of industry meetings were all applied. Every interview was carefully prepared by sending in advance an outline of the research and the area of interview to each interviewee and by studying background information relating to the company. With the aid of these materials the author could also monitor the interview and help the interviewees recall past events. In addition, All the case study reports were send back to the interviewees for final comments and error correction. In particular, opinions on the checklists method used in the data analysis for measuring the environmental constructs were invited and positive responses were received.

II. Organization of the Thesis

The thesis is organized into nine chapters. In Chapter 1, "The Literature Review", an overview of previous studies in the R&D/marketing interface field is provided. With reference to the frequently reported R&D/marketing interface problems, the limitation of the previous research is evaluated. The chapter is then proceeded to explore interlinks between the various disciplines and the R&D/marketing interface study. Organization studies, innovation research, strategic management and marketing are all included for this purpose. This provides a basis for the development of the inter-disciplinary research theoretical framework in Chapter 3.

Before the development of the framework, a description of the research methodology is provided in Chapter 2. This is because the development of the framework has also received certain input from the pilot study, which is described in Chapter 2. Following the specification of the research objectives, the decision on case study methodology is justified and the research population and sample are then selected under several major criteria. Next methods of data collection and precautionary measures on data reliability are described. At the end of this chapter methods of data analysis are explained.

In Chapter 3, on the basis of the literature review the role of the R&D/marketing interface is identified as the pursuit of competitive advantage by incorporating negotiated exchange between the two parties. Having defined specific research questions, three groups of potentially important research constructs from the literature are identified and research propositions regarding the relationships between the constructs are generated. Meanwhile, six major types of innovation projects are defined on the basis of an existing study by Calantone and Cooper (1981). At the end of Chapter 3, measurements of some constructs are developed in relation to the pharmaceutical industry.

Next in Chapter 4, the background of the pharmaceutical industry is provided as a necessary preparation for the four within-case studies regarding four pharmaceutical firms, which are to be carried out in the following chapters. This chapter is divided into six distinct sections. It contains comprehensive information regarding government regulation and patent law, market structure and competition, drug innovation process, risk and return in the R&D, the characteristics of the R&D/marketing interface in this industry and the performance of the U.K. pharmaceutical industry.

Before Chapter 5 - the first chapter of the four within-case studies - a brief introduction to the case studies is denoted. The structures of the four chapters, i.e. Chapters 5-8, are identical. Each starts with an introduction of the history, the innovation performance and the organizational structures of the case company. The main part of each chapter consists of the detailed case study write-ups of three specific drug innovation projects from the case company. Data from each drug innovation case study are organized under the three constructs identified in the theoretical framework. The constructs are then assessed by using qualitative methods defined in the framework, such as the checklists method, and a

preliminary discussion is provided. At the end of each chapter the results from the three within-case studies are summarized, which is guided by the research propositions.

Finally in Chapter 9, a cross-case analysis based on the previous four within-case analyses is carried out. It starts with a brief summary of the limitations of the existing studies which have inspired the current research. Next, an analysis of the empirical findings in relation to each of the three research questions is conducted. This then allows a general discussion at the end of the chapter on the theoretical and managerial implications of the empirical findings. Meanwhile several unexpected findings are emphasized.

III. Summary of the Important Research Findings

The case studies' results have generally supported the research propositions and further elaborated them. The results have confirmed that the role of the R&D/marketing interface in drug innovation covers the five dimensions. They are (a) the corporate strategic dimension, (b) the corporate technical dimension, (c) the product strategic dimension, (d) the product technical dimension and (e) the operational dimension.

However, the effectiveness of the R&D/marketing interface in the five dimensions varies considerably and the variation is influenced by the market and technological environment. According to the framework, the twelve drug innovation projects studied in the current research are classified into three major types, i.e. the "related-technology and existing-market" type, the "unrelated-technology and new-market" type and the "new-technology and new-market" type. It is found that (a) the R&D/marketing interface tends to be most effective in a "related-technology and existing-market" type of project and (b) the R&D/marketing interface tends to be more difficult to achieve in a "new- or unrelated-technology and new-market" type of project. Moreover, the results indicate that the desired level of the interface is not identical for all the innovation projects. It is higher for a "unrelated-technology and new-market" type of project than for a "new-technology and new-market" type of project.

Nevertheless, although the market and technological environment is a major factor affecting the effectiveness of the R&D/marketing interface, it is not the

sole influence. The environmental factors and the organizational factors have a combined effect upon the R&D/marketing interface. A weak R&D/marketing interface is found to be associated with poor drug innovation performance.

Meanwhile it is found that both the "marketing-driven" and "research-driven" projects can lead to successful product innovation. However, they are likely to be suitable for different technological and market situations. For instance, a "research-driven" project is likely to be associated with high technological uncertainty.

Several unexpected findings have been derived from the research. First it is found that a contingent technical problem occurred at the later stage of the innovation process can substantially increase the drug's technical complexity, thus seriously affecting the effectiveness of the R&D/marketing interface. Secondly, the results have revealed that fast development speed is an important but not an essential factor for every successful innovation project and a balance between development speed and development risk is more crucial. Finally, a lack of the strategic R&D/marketing interface in dealing with drug regulatory affairs is found.

The current research findings have several important managerial implications. The definition of the five interface dimensions can help managers identify more precisely their responsibilities and detect more accurately the weaker interface dimensions that need to be strengthened. Managers should also assess carefully the likely occurrence of any contingent technical problems and their impact upon the project so that necessary precautionary measures can be taken beforehand.

Finally, the current research has certain implications for the future research. The definition of the five dimensions of the R&D/marketing interface will provide the future research in this field with a crucial link to several academic areas. Also the research framework which has not been constrained to the pharmaceutical industry will provide the future research with the opportunity to study the R&D/marketing interface in other industries.

CHAPTER 1

LITERATURE REVIEW

1.1 INTRODUCTION

The R&D/marketing interface is a multi-disciplinary issue. As the title suggests, it is related to cross-functional interaction, R&D management, marketing management and so on. Numerous studies have identified the R&D/marketing interface as an important determinant of successful product innovation. In addition, previous research has exploited, theoretically as well as normatively, effective ways of managing the R&D/marketing interface.

However, most existing studies on the R&D/marketing interface have been limited to a single field such as organization studies or innovation research, which emphasizes either the internal factors affecting the interface or the external influence upon the interface activities at particular innovation stage. In addition, these studies have focused only at one level of the interface problems, either relating to the efficacy of structure linkages for achieving better corporate performance (Horwitch and Thietart, 1987) or concerning the effectiveness of functional integration for successful product innovation (Souder, 1988). Consequently, little has been known about the synthetic process of the R&D/marketing interface influenced by both internal and external factors. Specifically, this synthetic process can be described as a process in which functional areas pursue competitive advantage by incorporating negotiated exchange with internal coalitions.

This chapter starts with an overview of the existing studies in the R&D/marketing interface. In the organizational literature, for instance, the R&D/marketing interaction is viewed as a particular form of open social system, where interdependent processes emerge because of the specialization and division of labour (Ruekert and Walker, 1987). Meanwhile, in the innovation research, the interface pattern is related to the conditions of customers and internal R&D (Souder, 1988). With reference to the frequently reported R&D/marketing interface problems, the limitation of the previous research is evaluated.

Next, in order to improve our understanding of the multi-disciplinary nature of the R&D/marketing interface, we proceed to explore interlinks between the

various disciplines and the R&D/marketing interface. Organization studies, innovation research, strategic management, and marketing literature are included. The purpose is to establish a basis for the development of the theoretical framework in Chapter 3.

In the organizational literature, three major pairs of interrelated forces shaping the organization are outlined. They are interdependence and coordination, differentiation and integration and the relative influence of functional departments and organizational uncertainty. Apparently, the negotiated exchange process between R&D and marketing is influenced by these three pairs of forces.

Next, after product innovation is defined in terms of types, stages and activities, the R&D/marketing relationship is investigated in relation to its technological context. Two major issues are discussed, including the interface management within the R&D function and the incorporation of the interface activities in the corporate technological decision-making.

Finally, the potential of integrating R&D and marketing is explored from a marketing perspective. The central issues include (a) strategic marketing, (b) high technology marketing and (c) marketing research for product innovation. The emphasis is on the practical values of the existing marketing theories for the current empirical study.

1.2 THE EXISTING THEORETICAL AND EMPIRICAL STUDIES IN THE R&D/MARKETING INTERFACE

1.2.1 Organization Theory on Relationships

Researchers in this field stress the complexity and importance of managing interfunctional relationships within organization. One of the studies in the R&D/marketing interface was pursued by Ruekert and Walker (1987). From a social system perspective, they developed a conceptual framework to understand how, why and with what results marketing personnel interact with personnel in other functional areas in carrying out marketing functions. Like all social systems, the interfunctional interaction has two important characteristics:

- (a) Behaviour among the members of the social system is motivated by both individual and collective interests.
- (b) Interdependent processes emerge because of the specialization and division of labour.

Ruekert and Walker suggest that an important aspect of such coordination is the use of roles and standard operating procedures to increase the efficiency of repetitive interactions. On the other hand, because formalized rules cannot be developed for every eventuality, the opportunity for informal influence over decision is present.

The study defines several important variables including environmental, structural, and process variables. The major internal environmental variables influencing the interaction are defined as

- (a) resource dependence,
- (b) domain similarity¹, and
- (c) the nature of the strategy.

Whilst, the structural and process variables are divided into

- (a) transactions,
- (b) communication flows, including the amount of communication² and communication difficulty³, and
- (c) coordination mechanisms.

An empirical test based on this framework was conducted. This was however, limited to the internal environment. One of the important findings of the research is that the more dependent the two functions are on each other, the more communication they have. However, more communication flows also lead to more conflict, which in turn reduces the effectiveness of the interaction. This indicates that to increase the amount of communication is not sufficient for an effective interaction.

Research has been carried out by Saghafi, et al. (1990) on an attempt to identify the states of the R&D/marketing interface and the causes of the interface problems. Managers were asked to compare between the desired level and the

actually achieved level of the R&D/marketing integration. The lack of an appropriate level of R&D/marketing integration was found. Inadequate communication, marketing's lack of understanding of technology and R&D's lack of market orientation were cited as the most important barriers to effective integration.

Similarly, Gupta and Wilemon (1988) found that, in technology intensive companies, the lack of credibility of marketing information perceived by R&D, influenced the R&D-marketing cooperation. Credible marketing information is characterized by its feasibility, validity, and consistency.

However, neither of these studies has identified the specific market and technological conditions under which the interface problems have occurred.

1.2.2 The R&D/Marketing Interface in Product Innovation

Researchers in innovation management have approached the R&D/marketing interface issue from an external perspective. For instance, having observed seven R&D/marketing interface states⁴, Souder (1988) proposes a framework for the R&D/marketing integration: the Customer-Developer-Condition (CDC) model. In this model, according to their levels of sophistication, customers and the firms' R&D departments are divided into different groups respectively. Customers' level of sophistication is defined in terms of their need awareness and their ability to communicate their needs. R&D's level of sophistication refers to their understanding of products and their technical means to develop the products.

Souder suggests that, according to the condition of the customers and the R&D groups, the interface pattern may be different. For instance, for customers who fully understand their needs but are unable to translate them into product specifications, marketing plays a leading role. A series of activities such as need translation and development of prototypes based on these translations will be carried out with a continued interfacing of R&D and marketing.

It is apparent that these two dimensions of R&D and customers correspond to the dimensions of technology and market. For example, that customers do not understand their needs is possibly associated with a new market situation. While low level of R&D sophistication is likely to be associated with a new

technology situation. Thus, the R&D/marketing interface needs and states are directly linked to the market and technological condition.

In addition, the R&D/marketing interface has been examined in both market-driven and innovation-driven high technology situations. Shanklin and Ryans (1984) suggest that:

"for the purpose of discussing marketing-R&D linkage, the most important distinction is between what we have called market-driven and innovation-driven high technology" (pp. 166)

According to Shanklin and Ryans, the R&D/marketing interface need is different in these two situations. In an innovation-driven situation, the company's top strategic and marketing objective is to achieve profitable commercial applications for laboratory output. In this case, possibilities for commercial applications may be less obvious or so numerous that the company must establish priorities for exploitation. Thus R&D is the prime mover behind marketing's efforts.

On the other hand, a market-driven high technology situation emerges as high-tech markets mature. In this market-driven situation, R&D's task is to respond to the specific market needs identified by marketing and other sources. The linkage comes primarily through R&D's active participation in the market planning process.

Research in the R&D/marketing interface is also concerned with particular stages of product innovation. Product design stage has been the main emphasis. It is concerned with the role of the R&D/marketing interface in the translation of an industrial idea or concept into a product with tangible properties and features (Gersterfeld, 1976). Studies in this field hold that product design is an important segment of the new product development process and there is an essential need for marketing and R&D to effectively interface during the design step (Bonnet, 1986; Gerstenfeld, 1976; and Souder, 1981). The quality and adequacy of market research techniques and their implications on the effective R&D/marketing cooperation are the main theme.

Chakrabarti and O'Keefe (1981) revealed in their study that two of the most important factors leading to product success were clearly related to market intelligence and information gathering: recognition of customer needs and superior techniques for data gathering, analysis and decision-making. However, R&D/marketing problems were observed that product developers did not always incorporate important market data in their development and launch decisions, and market researchers did not achieve adequate acceptance because they failed to sell their services effectively.

Bonnet (1986) emphasizes a design link between R&D and marketing in technology advanced firms by dividing the R&D/marketing interface into two key areas, respectively the market dimensions assessment and the product dimensions assessment. The purpose of the market dimensions assessment is to investigate the commercial viability of a new project and the way in which it fits the firm's internal strategy. Meanwhile, in the product dimensions assessment, R&D by its technical capability and marketing by its market knowledge, try to optimize the design characteristics of the product. Bonnet's study revealed that one of the major areas of difficulty in product dimension assessment was the extrapolation of customer requirements over the development period and the reconciliation of differing requirements from customers over the same period. There was a lack of appropriate marketing research methods in this situation. Bonnet stresses that, ideally, such an assessment would provide the R&D department with a satisfactory balance between technically viable and commercially viable product characteristics which would then be integrated into the product design to maximise its marketability.

In summary, the role of the R&D/marketing interface in the pursuit of firm's competitive advantage through product innovation has been addressed in the innovation research field. The differences in the R&D/marketing interface need, states and effectiveness under different market and technological situations are recognized. However, the negotiated exchange process with internal coalitions during the pursuit of competitive advantage has been largely ignored.

1.2.3 Studies Towards an Integration of Organizational Theory and Innovation Research

The most recent development in the R&D/marketing interface area has been toward a cross-disciplinary fertilization. Moenaert et al. (1992) point out that

"the studies that have investigated the effect of new product development on project success have not examined the interfunctional interfaces for each of the innovation cycle stages separately (e.g. pre-development, development, launch)" (pp. 382)

They propose a model linking concepts from organizational theory to innovation management at the earlier planning stage. They maintain that successful project teams are characterized by a maximum uncertainty reduction during planning. Information flows between functions help those functions achieve this efficient uncertainty reduction. Moreover, they suggest that the task uncertainty of a project varies, depending on market newness and technological newness. Thus, entering new markets implies that the marketing members of the project cannot refer to an in-house body of marketing knowledge that has been accumulated through past experience. Therefore, the marketing task uncertainty will be higher. Similarly, if the organization begins a project in unknown technologies, the task uncertainty faced by R&D will be much higher than that of projects launched in areas that show a strong technological synergy.

Moenaert's research provides a critical link between the newness of market and technology, and the interface activities of the project team. Therefore, different interface patterns at the planning stage of product innovation are expected for different types of innovations carried out. However, as the research concentrates only on one of the several critical stages of product innovation, the planning stage, data regarding the relationship between the types of innovation and the interface activities at the other stages of product innovation were not provided.

1.2.4 Common R&D/Marketing Interface Problems and Limitations of the Existing Research

The R&D/marketing interface has been assessed by previous research at two levels and in two dimensions. The two levels are the departmental level which is not concerned with the specificity of projects (Ruekert and Walker, 1987) and the project team level (Souder, 1988; Moenaert, et al. 1992). In the meantime, the R&D/marketing interface is evaluated along two dimensions, including market (or strategic) dimension (Souder, 1988; Moenaert, et al. 1992; Shanklin and Ryans, 1988) and product (or technical) dimension (Bonnet, 1986).

Problems have been reported at each level and in each dimension from different perspectives. Ruekert and Walker (1987), for example, found that interdependence between the R&D and marketing leads to more communication flows. However, more communication flows also lead to more conflict, which in turn reduces the effectiveness of the interaction. The dilemma here is how to increase the amount of communication flows, at the same time to reduce the conflict which may occur as a result of the frequent contact between these two parties.

Souder (1988) discovered that the interface need between the R&D and marketing may vary, depending on the market and technological condition. This in turn calls for the R&D and marketing parties to establish a team relationship that permits them to flexibly swap roles in response to evolving technologies, markets and customer needs. However, this type of activity has been considerably limited by the present organization structures, which largely emphasize a clear separation of roles and specialization of functions between R&D and marketing.

Shanklin and Ryans (1984) illustrated a contrasting picture of the R&D/marketing interface in a market-driven high technology situation as opposed to that in an innovation-driven high technology situation. While R&D is the prime mover behind marketing's efforts in the latter, R&D's task is restricted to responding to the specific market needs identified by marketing and other sources in the former. Consequently, interface problems may occur from this substantial power deviation between these two parties.

The inappropriateness of marketing research techniques, especially in assisting new product design, is another source of the R&D/marketing interface problem (Bonnet, 1986). This sometimes results in the R&D's perception of marketing information as non-credible, which has a negative effect upon the R&D/marketing cooperation (Gupta & Wilemon, 1988).

Meanwhile, McNulty and Whittington (1992) has revealed the R&D/marketing interface problems under special circumstances, i.e. within R&D organizations. They suggest that the interface problems between R&D and marketing may stem from R&D's biased view of marketing's role. They found that professional technologists in the R&D organization often perceive marketing's role simply as selling, for which they are lacking of technical expertise. In this sense, R&D people think they are natural marketers and look down marketing.

Odioso (1987) who worked as a R&D director in a large chemical company for thirty years suggested several potential sources for the interface problems between R&D and marketing. They are:

- (a) the desire of R&D staff to develop truly superior and unique products and the limited ability of marketing in relating to a completely new product category;
- (b) the risky and trial-and-error nature of an innovative project and the unfeasible expectation of marketing sometimes toward new product development;
- (c) the strategic need to move into new technologies where results are uncertain and the adherence to mature technologies that offer immediate but marginal improvements.

Clearly, the first source of problem addresses the need to develop appropriate marketing strategies and techniques suitable for truly innovative high technology products, while the second one suggests an association between the interface problems and the types of innovation. In addition, It indicates a link between the types of innovation outcome (low-risk incremental or high-risk radical) and the relative influence of the R&D and marketing departments. Finally, the third source of problem emphasizes the importance of the R&D/marketing interface in the formulation of firm's technological strategy.

Since previous research could not cope with the scope of the interface problems discussed above, a multi-disciplinary approach needs to be developed. In order to fulfil this goal, a broader background knowledge in the related areas is required, and is presented next.

1.3 A BROADER REVIEW ON ORGANIZATIONAL PERSPECTIVES

Although not directly related to the R&D/marketing relationship, findings of many studies in the organizational literature have revealed important characteristics underlying inter-group behaviour. These findings have a great value to the development of the theoretical framework of the current research.

1.3.1 Interdependence and Coordination

Interdependence exists within organizations. Different functions depend on each other for information and other human and financial resources to accomplish their organizational tasks (Child, 1977). On the other hand, differences in background, education, experience, and various social characteristics may cause coordination problems between the different functions. Interfunctional interdependence is further classified into three forms: pooled, sequential, and reciprocal (Thompson, 1967). Thompson points out that all organizations have pooled interdependence, more complicated organizations have sequential as well as pooled, and the most complex have reciprocal, sequential, and pooled.

Meanwhile, three types of coordination are identified. They are coordination by standardization, coordination by plan and coordination by mutual adjustment. Coordination by standardization involves the establishment of routines or rules which constrain action of each unit or position into paths consistent with those taken by others in the interdependent relationship. Coordination by plan involves the establishment of schedules for the interdependent units by which their actions may then be governed. Coordination by mutual adjustment involves the transmission of new information during the process of action. Thompson has observed distinct parallels between the three types of interdependence and the three types of coordination, and the three types of coordination place increasingly heavy burdens on communication and decision.

1.3.2 Differentiation and Integration

While Thompson has implied the influence of external environment on the interfunctional relationship in terms of the types of interdependence and the types of coordination, Lawrence and Lorsch's (1967) contingency theory explicitly recognizes the impact of external environment upon the degree of differentiation and integration of an organization. They maintain that organizations functioning in a dynamic and diverse environment are highly differentiated. Their findings indicate that the states of differentiation and integration are inversely related. The more differentiated an organization, the more difficult it is to achieve integration.

To overcome this problem, effective organizations have integrating devices consistent with the diversity of the environment. They can range from an integrative department to an individual integrator, and from permanent cross-functional teams at three levels of management to temporary cross-functional teams, etc.

1.3.3 Relative Influence of the Functional Departments and Organizational Uncertainty

Numerous studies in the organizational literature have established an important link between the relative influence of the functional departments and the organizational contingencies. Turner and Giles (1981) explain the power in organization as the ability to cope with critical organizational uncertainty, which is defined as the contingencies that the organization faces. It may be rapidly changing technologies, intensive competition in the market and so on. They maintain that the groups that possess the most appropriate skills and the information to cope with the critical uncertainty come to have stronger influence. The theories of informal social communication also emphasize the importance of coping with uncertainty. Festinger (1954) demonstrates that uncertainty leads to increased social communication. Uncertainty then provides the group that can reduce it with the opportunity to obtain increased control in the organization.

While most organization researchers give some degree of consideration to the environmental context of organization, Pfeffer and Salancik (1978) take the

view of externally controlled organizations much more strongly. They contend that because resource acquisition may be problematic and uncertain, organizations depend on their environment. They define organizations as "coalitions of varying interests". They argue that the influence of different participants in an organization, so as to the extent their varying interests can be satisfied, varies depending on their ability to cope with critical contingencies. The frequently occurred incompatible preferences and goals among the participants are a major cause for inter- as well as intra-organizational conflict, which makes the management of organizations difficult.

1.3.4 Summary

Three pairs of interrelated forces are discussed in this section. They have a major influence upon intergroup behaviour, and thus upon the R&D/marketing relationship. It is suggested that both interdependence and coordination are needed between organizational functions. However, coordination problems may occur due to differences in background, education, experience and various social characteristics between the different functions. Moreover, there exist different types of interdependence as well as different types of coordination. Therefore, it is implied that coordination problems can also be caused by the mis-match between the type of coordination and the type of interdependence. In addition, the studies indicate that the communication need between the different functions may vary according to the type of interdependence or coordination.

The need for both differentiation and integration between different functions within an organization is also addressed. However, this need is difficult to achieve especially in a dynamic and diverse environment when the organization is highly differentiated.

Finally, it is found that the influence that the different functional areas can have upon their relationship is not constant. Instead, it varies depending on the ability of these areas to cope with critical contingencies. Because the preferences and goals between the functional areas are not always compatible, inter-functional conflict may occur as different functional areas fight for more control.

Apparently, these factors have a major impact upon the efficiency of inter-group relationship. However, the organization theories concerning inter-group

relationship are incapable of dealing with the R&D/marketing relationship in full, since the abstraction of a variety of relationships into "inter-group" relationship has taken away their original context. Thus, the effectiveness of the R&D/marketing relationship in relation to the organization's technological conditions and market competitive position cannot be appropriately evaluated.

1.4 A BROAD REVIEW ON INNOVATION STUDIES

The growing interest in innovation has been largely triggered and stimulated by events in the contexts of organizations. However, the problem of innovation in organization studies has been theorized in a very restrictive and simplistic manner. The focus is upon efficiency with innovation as the deviant case (Clark & Staunton, 1993). Innovation studies, on the other hand, have largely elaborated organization theory by taking into account organization's internal and external technological conditions as well as firm's competitive positions (Fox, 1973; Mile & Snow, 1984; Rockart, 1979; Hitt & Ireland, 1982).

Innovation can be viewed both as activities and process. Thus, innovation activities are dynamic inputs to the innovation process (Brown & Karagozoglu, 1989). The inputs include both decision inputs and implementation inputs. The decision inputs are concerned with the overall company strategy and its technology policy, while the implementation inputs are related to an organization's structure, information and manpower flow and the role specification.

In correspondence with Brown Karagozoglu's view, McGee and Thomas (1989) propose issues of "confidence" and issues of "emergence" in innovation process. Issues of confidence concern company's decision to commit resources to technological change, reflect the coherence of its strategy and its attitude to risk. While issues of emergence focus on the processes which shape the decision-making and carry technological change through to the market. It is apparent that the R&D/marketing interface has an important role to play at both levels.

In this section, the R&D/marketing relationship is related to its technological context. Following an introduction of the types and stages of innovation, the role of the R&D/marketing interface in management of the R&D function - the

function that carries out technological change - is discussed. Next, the importance of the R&D/marketing interface at the corporate level in deciding company's resource commitment to technological change is explored, where the concept of the "core" technological competence of the firm is brought up.

1.4.1 Types and Stages of Product Innovation

(1) Types of Innovation

In innovation research, effort has been made to classify various types of innovation. According to technological newness and market newness of an innovation, it may be classified as either radical or incremental (Utterback & Abernathy, 1975). With regard to the competitive consequences of these two types of innovation upon the firms, Dussauge et. al. (1992) suggest that incremental changes reinforce the positions of established firms while radical innovations force incumbents to develop new skills and capabilities.

On the other hand, Calantone and Cooper (1981) have identified nine types of new product scenarios through empirical investigation, such as the "Synergistic Close To Home" product, the "Better Mousetrap with No Marketing" product, the "Synergistic Product That Was New to the Firm" type, the "Innovative Superior Product with No Synergy" and so on. The following six blocks of variables listed are the main criteria for this categorization.

- (a) the commercial entity of the new product
- (b) the nature or quality of information acquired during the new product success
- (c) nature of the marketplace
- (d) proficiency of process activities
- (e) the compatibility of the resource base of the firm with the requirements of the project
- (f) nature of the project

Each new product type has a different combination of these variables. Although some of them are facing a similar external market and technological condition, they differ in their marketing proficiency and technological strength of the firm. Thus, their successful record is also different. It is observed by the author that

when merely considering their external technological and market condition, these nine new product types fall into six categories, as illustrated in Figure 1.1.

Figure 1.1 The Technology-Market Dimension Matrix

Technology			
Related to the firm		A	B
Unrelated to the firm		C	D
New to industry		E	F
		Existing	New
		Market	

- (a) Type A is the "related-technology and existing market" type of product. It includes the "Synergistic Close To Home" product, and so on.
- (b) Type B is the "related-technology but new-market" type of product, which may include the "Better Mousetrap With No Marketing" product.
- (c) Type C is the "unrelated-technology but existing market" type of product. The "Innovative High Technology" product is likely to belong to this category.
- (d) Type D is the "unrelated-technolgy and new-market" type of product. The "Me To Product With No Technical Synergy" may belong to this type.
- (e) Type E is the "new-technology but existing-market" type of product. The "Innovative Mousetrap That Really Wasn't Better" may belong to this type.

(f) Type F is the "new-technology and new-market" type of product. The "Synergistic Product that was New to the Firm" product and the "Innovative Superior product with No Synergy" type are likely to be in this category.

Calantone and Cooper's (1981) approach offers a new way for managers to consider the attractiveness of new product proposals. It emphasizes the evaluation of the impact of a series of process activities, technological factors and market factors on the eventual outcome. The importance of a company's technical resources, including production resources, skills of engineering staff, experience in research and development, sufficient development funds, and recognition of a technical opportunity in product success is stressed.

(2) Stages of Innovation

Although the product planning and development varies from industry to industry, its activities generally follow the pattern described below (Hisrich & Peters, 1984).

- (a) idea stage: suggestions for new products are obtained from all possible sources, and their values for the achievement of company's long term objectives and growth are analyzed;
- (b) laboratory development stages: ideas are now developed in the laboratory into more elaborate product concept backed up by a preliminary marketing program;
- (c) product development stage: technical and commercial aspects of the potential new product are explored and the prototype is developed in the light of production problems, safety requirements, and costs;
- (d) test marketing: valuable data on the nature of market, the needed marketing strategy and product modification are provided to ensure a successful launch.

Pinto and Slevin (1989) argue that the project development stages have important implications for prioritizing critical successful factors. They have identified ten critical success factors in R&D projects, such as project mission, top management support, project schedule, client consultation, technical tasks,

monitoring and feedback, personnel, and environmental events, and so on. They find that the relative importance of these factors changes depending on the stage in which the project currently resides. Thus, while client consultation and personnel are most important in the conceptual stage, environmental effects, monitoring and feedback are most crucial in the planning stage, etc. Similarly, Brown and Karagozoglu (1989) find that the personal values of top managers have a major influence on innovation in the idea generation stages. However, in advanced product development and market research activities, the incorporation of a element of flexibility into the strategy formulation becomes essential for encouraging R&D and marketing integration.

1.4.2 R&D Management

According to Dussauge et al. (1992), the first problem that technology-based strategies pose concerns the management of the R&D function, i.e. the function which develops technology. From a R&D perspective, differentiation is essential to fundamental innovation, since marketing often has difficulty sensing opportunities in the scientific and technological environment. On the other hand, integration with marketing is equally important to ensure a marketable output rather than a technological chimera.

In this area, apart from the consideration of market and technological factors in project selection, the importance of an effective R&D/marketing interface in maintaining a crucial balance between development speed and development risk is also been recognized. Krusik (1988) points out that:

"the opportunity cost of missing a fast-moving market window and the risk of entering a market with the wrong product pull managers in opposite directions" (pp. 46)

Although both the novelty of the product and the speed of the product development are a possible source of competitive advantage for the firm, their relative importance to the firm varies depending on the market environment. When the competitive environment is changing rapidly, and product life cycles are being substantially shortened, the opportunity cost of missing a strategic window is very high. Thus, development speed becomes critical. However, being fast to market is no advantage if managers choose the wrong technology

or create a design that customers do not want. In addition, there are situations when markets and technologies are new and highly uncertain, yet, the competitive environment is relatively stable, emphasis may instead be put on acquiring crucial information and reducing the technical risk of the development rather than speeding up the development. In other words, R&D managers need to identify and act on the particular circumstances in which they find themselves. In order to achieve this, a close interface with their marketing counter-parts to understand the market condition and the competitive environment is highly desirable.

In addition, the need for distinct managerial approaches in Research and Development sections is also stressed (McGee & Thomas, 1989). Since broadly focused, more basic research is different from narrowly focused, more incremental development work. There are greater technological uncertainties in the Research outcomes, whereas development decisions are more explicitly commercial and involve much shorter time scale. This implies that the R&D/marketing interface issue has to be examined in a greater detail, as far as the innovation stages are concerned.

1.4.3 The Core Technological Competence of the Firm

The innovation outcome of a firm, in terms of size, radicalness and direction is largely influenced by the firm's corporate strategy regarding the resource commitment to technological changes (Coombs, et. al., 1987). A firm's technological strategy reflects its attitude to risk (McGee & Thomas, 1989), and this in turn, affects the firm's long term growth. According to Capon & Glazer (1987)

"Firms that choose to approach the technological frontier place themselves at risk, for technology research, development, and exploitation are by definition uncertain. However, though remaining in familiar product-market situations reduces current uncertainty and may ensure current profits, the avoidance of technological risk today may lead to considerable market risk tomorrow" (pp. 3).

The real 'paradox' of technology can thus be stated in the form of a question: how can the company simultaneously achieve efficiency in existing operations

(incremental change) as well as effective repositioning and innovation for the future (radical change).

Traditionally the strategy literature treats technology as an implementation issue. The firm determines its strategy and, this in turn, defines how technology will be used (McGee & Thomas, 1989). More recently, strategic management researchers in areas such as corporate diversification and organization structure have identified important technological dimension. Meyer and Roberts (1988) identified three basic choices in terms of technology in planning product development. They are:

- (a) building a critical mass of technological skills for a closely related product portfolio, believing that the distinctive competence it achieved will become the basis of long-lasting competitive advantage;
- (b) targeting unrelated technologies, which results in a diverse set of products that does not depend on a single core technology;
- (c) creating a diverse product portfolio through acquisition, avoiding the long-term effort of building the required technological expertise internally.

These technological choices differ in terms of their dependence on the firm's core technology. Meyer and Robert (1988) suggest that the first choice yields a distinctive core technology that becomes the foundation of the company's product development. They argue that without a defensible core technology, the technological venture typically had difficulty assuming a leadership role in its target markets and found itself playing catch-up with competitors.

Pavitt (1986) also emphasizes the importance of the "core technologies" in successful innovation. He suggests that

"entry and exploitation of new product markets based upon technological skills will create significant short term costs and such innovations are most likely to be successful when are used on core technologies close to the existing product market and technology mix of the firm" (pp. 87).

Therefore the most important conclusion drawn from the above analysis is that the firm's potential for innovation and for economic return is strongly conditioned by the historical trajectory of innovative activity in the past (McGee & Thomas, 1989).

It is clear that a firm's decision-making on its technological strategy is a constant search of a dynamic balance on a three dimension matrix, i.e. market risk, technological risk and firm's long term growth. However, an understanding of the role of the R&D/marketing interface in deciding firm's technological strategy at the corporate level is still very much lacking.

1.4.4 Summary

In this section, the role of the R&D/marketing relationship or interface has been investigated from a technological perspective both at the functional level - the R&D management and at the corporate level - the decision-making of firm's technological strategy. At the functional level, it is suggested that an effective R&D/marketing interface is important to ensure a marketable innovation output. It is further pointed out that an effective R&D/marketing interface is not only critical for a project selection but is important throughout the R&D process to maintain a crucial balance between development speed and development risk. In addition, the need for R&D managers to adopt distinct managerial approaches for the Research and the Development sections is proposed owing to the different technological uncertainties and commercial implications they are involved.

Next, at the corporate level, the role of the R&D/marketing interface in deciding firm's technological strategy is discussed. A firm's technological strategy is concerned with the firm's resource commitment to technological changes, which has a major impact upon the firm's long term growth. Since one of the major considerations in deciding firm's technological strategy is the dynamic balance between the market risk, the technology risk and the long term business growth, an effective R&D/marketing interface should be incorporated into this decision-making process.

1.5 A BROAD REVIEW ON MARKETING PERSPECTIVES

The issue of marketing's contribution in technological innovation is only implicitly considered in the marketing literature. Abell (1987) describes the firm's marketing effort, which is aimed at capturing opportunities or avoiding threats brought about by the advent of new technology, as meeting the changing needs of the customer and penetrating new potential markets so that the firm's sustainable competitive advantage can be built up and further maintained. Similarly, Rosenberg (1988) maintains that

"the innovation emphasis is in the direction of proactive behaviour. An initiative posture as opposed to a reactive mode, demands that the firm cope with a high degree of environmental uncertainty. ...For such proactive firms, better and more timely market intelligence to integrate product innovation, product commercialisation and product diffusion is far more critical" (pp. 201)

The importance of this focus is reinforced by findings of Cooper (1983). The findings indicate that a firm's new product strategy is an essential component of its overall planning, with significant correlations between overall performance and (a) extensive use of market research for new products, (b) proaction in identifying market needs for new products, and (c) market-derived new product ideas.

However, despite the recognized importance of marketing in successful innovation, a field that integrates technology and marketing and accounts for the instrumental role of technological innovation in generating customer value has been far lacking. Bender (1988) argues that only first-order derivatives of the technological innovation literature have found their way into marketing via the new product development discipline and the learning curve "effect". The marketing literature thus addresses (a) incremental innovation only indirectly and (b) radical innovation not at all.

Nevertheless, the potential of further integrating marketing and technological innovation has emerged with both areas moving toward a strategic orientation. In this section, effort is made to investigate the R&D/marketing interface in product innovation from a marketing perspective. First the concept of strategic

marketing and its recent development are introduced. Next a new area in marketing management, high technology marketing, is discussed. It addresses the marketing needs in a high technological environment which is characterized by the high technological uncertainty and high market uncertainty.

1.5.1 The Strategic Marketing

The discipline of marketing is constantly being reshaped by internal and external forces. The most obvious forces stem from developments in strategic management and planning (Day & Wensley, 1988). A prevailing debate is centred on the appropriateness of the traditional marketing paradigms - the allied notions of consumer choice and consumer satisfaction and the four P's (Arndt, 1979). It is argued that traditional paradigms in marketing give little explicit attention to competitive forces (Day & Wensley, 1988). However, the tentative move toward strategic orientation bears the risk of role confusion with strategic management, depending on the extent of shared interests between strategic marketing and strategic management. Wensley (1982) argues that many developments in strategic marketing analysis that strive to provide generalized diagnoses and prescriptions have deflected marketer's attention from the critical issue of the demand-based sources of competitive advantage.

Day and Wensley (1988) propose a link between marketing theory and strategic management as follows:

- (a) product-market information is essential for corporate management to make many strategic judgments.
- (b) marketing activities including the identification of market opportunities, the analysis of new product demand and the development of product life cycle forecasting are key inputs into any attempt to achieve an effective commercial balance in the strategic portfolio.

Meanwhile, the relationship between marketing and strategic management has been studied from a strategic planning perspective. Anderson (1982) asserts that the ultimate objective of the firm may be seen as an attempt to position itself for long run survival. This, in turn, is accomplished as each functional area

attempts to determine the position that will ensure a continuing supply of vital resources.

Since a firm's functional areas may not be able to occupy all of the favoured long run positions simultaneously, strategic conflicts will arise as functional areas vie for financial resources necessary to occupy their optimal long-term positions. Corporate management as the final arbiter of these disputes may occasionally favour one area over another, with deleterious results.

Against this backdrop, Anderson (1982) argues that marketing must realize that its role in strategic planning is not preordained, unless marketers adopt a strong advocacy position within the firm. On this view, strategic plans are seen as the outcome of a bargaining process among functional areas. Thus, from a constituency-based perspective, marketing's role in strategic planning reduces to three major activities:

- (a) long-term strategic positioning at both corporate and divisional levels through the identification of customers' needs over the firm's strategic time horizon.
- (b) the development of intermediate strategies designed to capture its preferred positions, which will involve attempts to gain a competitive advantage over firms pursuing similar positioning.
- (c) negotiation activities with top management and the other functional areas to implement its strategies.

This approach suggests that the role of marketing in strategic planning must be that of a strong advocate for the marketing concept. This is critical since the other areas are likely to have biased view about marketing as merely selling (McNulty & Whittington, 1992). In addition, marketing's advocacy will be enhanced to the extent that it effectively communicates the true meaning of the marketing concept in terms that are comprehensible to other coalitions in the firm. This requires an intimate knowledge of the interests, viewpoints and decision processes of these groups.

It is notable that the marketing activities suggested above remain at a normative level. In practice, the responsibilities of marketing vary considerably. Hooley et al. (1990), for example, suggests a strong association between the role of a

marketing department and the company's marketing approach. Specifically, the company's approach to marketing, whether it is a "marketing philosopher", a "sales supporter" or a "departmental marketer"⁵, is found to be associated with the scale of marketing's responsibilities in the organization, the closeness of its working relationships with other functional areas and the amount of input that marketing provides to the company's strategic planning. In particular, it was revealed that, whilst the "sales supporters" had very restricted views on marketing's responsibilities in the organization, the "marketing philosophers" demonstrated the widest responsibilities, the closest cross-functional working relationships and the strongest involvement in strategic planning.

1.5.2 High Technology Marketing

The role of marketing varies not only with the internal factors but also with the external factors. The complexity of marketing practice stemming from the uncertain nature of a high technology environment (Shanklin & Ryans, 1992) is increasingly recognised. The demand for strategic marketing inputs, innovative marketing research techniques, and the R&D/marketing integration has been the main theme.

Moriarty and Kosnik (1989) define High-tech as high uncertainty about technology and the market. Firstly, market uncertainty refers to the ambiguity about the type and extent of customer needs that can be satisfied by the technology. According to Moriarty and Kosnik, market uncertainty exists mainly because of the three factors:

- (a) confronted with a radically new technology, customers may not understand what needs the technology can satisfy;
- (b) customer needs, once known, may be subject to unpredictable changes as the environment evolves;
- (c) predicting the rate of a high-tech innovation diffusion is difficult.

All the preceding factors make it difficult to determine the size of the potential market and to detect the customer requirements on new product feature.

Secondly, technology uncertainty results from not knowing whether the technology can deliver on its promise to meet needs, once they have been articulated. There are five potential sources of technological uncertainty:

- (a) a lack of information about a product's functional performance;
- (b) a lack of established production skills and facilities for the new product delivery;
- (c) a lack of experience which may result in poor service;
- (d) the technology may have unanticipated side effects;
- (e) threat of technological obsolescence.

Consequently, high-tech marketers are facing big challenge in the following areas:

- (a) the greater minimum acceptable knowledge base needed to understand the market potential and to build up credibility with their counterparts in R&D;
- (b) the frequent need to update their skills and knowledge with the rapid evolving customer preferences;
- (c) the strong need for cross-functional interaction.

1.5.3 Marketing Research for Product Innovation

Marketing research has been recognized as one of the important factors in strategic planning and product innovation. More (1984) defines market research as information search by managers in order to reduce situational uncertainty. The search activities might include an examination of market statistics, visits to potential customers, field tests of prototypes, test marketing, surveys and so on. Calantone and Benedetto (1988) emphasize the importance of relevant information about competitive products and strategies and about consumer tastes and wants in making better marketing as well as technical decisions. They suggest that:

"adequate performance of market intelligence activities should improve performance of certain technical activities as well as other marketing activities" (pp. 204).

The integrating role of marketing research with new product innovation is defined by Rexroad (1983) as providing a link between the technology base, customers and competitors. Gupta (1985) contends that this integrative need is dependent on the degree to which the firm's strategy is proactive and the extent of environmental uncertainty as related to consumers and their needs, technological dynamics and the competition.

More (1984) examined the relationship between the timing of market research and the situational uncertainty facing a particular new product innovation. The situational uncertainty was measured in terms of marketing task similarity, distribution complexity, competitive advantage, buyer risk and development complexity. He found that companies faced with less market task similarities tended to do earlier market research. Earlier market research was also noted in situations involving few unique product features. Earlier research also tended to be done in situations involving greater buyer risk. Significant differences were observed in the timing of market research for the different projects studied. The findings highlight the importance of recognizing the uniqueness of each new product situation and the need to carefully and explicitly plan resource commitments to market research. The issues of uncertainty and timing of marketing research are critical, especially for high technology firms, because market research contributes to the reduction of risk and uncertainty,

However, despite the awareness of integrating marketing research and product innovation, discussion of the nature of the information has been relegated to its more traditional market measurement and sales estimation functions, neglecting its role in providing critical environmental inputs for a corporate decision on product innovation, in terms of users and competitors, technological dynamics and possible governmental intervention (Rosenberg, 1989). Moreover, the importance of marketing research in helping the R&D department design unique new product features which are at the same time valued by customers has been largely ignored (Bonnet, 1986).

1.5.4 Summary

In this section, issues regarding marketing's role in product innovation are brought up. It is found that although in the marketing literature, innovation topics are largely ignored, several relatively new areas within the marketing literature have demonstrated a strong strategic or technological focus. This provides a great potential for an improved understanding on the R&D/marketing interface from a marketing perspective. These promising areas include (a) strategic marketing, (b) high technology marketing and (3) marketing research for product innovation.

The strategic focus of marketing management, in correspondence with the newly identified technological dimension within strategic management literature, has laid an important foundation for the research into the R&D/marketing interface at the corporate level. In addition, from a strategic planning perspective, marketing's role is considered to include (a) long-term strategic positioning at corporate level, (b) the development of intermediate strategies and (c) negotiation activities with top management and the other functional areas to implement its strategies (Anderson, 1988). This perspective has an important theoretical implication upon the R&D/marketing interface study. It emphasizes the importance of the R&D/marketing interface in accomplishing marketing goals. However, it is important to note that these three areas of marketing's responsibility remain at a normative level. In practice, a considerable variation of the marketing's responsibility is found, depending on firms' marketing approach (Hooley, et al. 1992). The findings reveal the importance of relating marketing theory to marketing practice.

In addition, a closer integration of technology and marketing is embraced in the area of high technology marketing. It addresses the complexity of marketing practice stemming from the uncertain nature of a high technology environment, which is characterized by high technological uncertainty and high market uncertainty. This highly uncertain high-tech environment has posed greater challenge to marketers including the need to interact with R&D and the difficulties involved in achieving an effective R&D/marketing integration.

Finally the importance of marketing research in uncertainty reduction and product design is emphasized. However, it is revealed that marketing research

has been mainly conducted for marketing considerations, its role in providing critical environmental inputs for a corporate decision on product innovation as well as in helping the R&D department design superior new product feature has been largely neglected.

1.6 CONCLUSION

The literature review has been divided into two major parts. The first part presents an overview on previous studies, where the R&D/marketing interface is assessed at two levels and in two dimensions. The two levels are the departmental level which is not concerned with the specificity of projects (Ruekert and Walker, 1987) and the project team level (Souder, 1988; Moenaert, et al. 1992). The two dimensions include market (or strategic) dimension (Souder, 1988; Moenaert, et al. 1992; Shanklin and Ryans, 1988) and product (or technical) dimension (Bonnet, 1986). Problems have been reported at each level and in each dimension from different perspectives. Since these interface problems have exceeded the scope of the existing research in the separate fields, a multi-disciplinary approach needs to be developed.

As a result, a broader literature search across the areas of organization theory, innovation management, strategic management and marketing is conducted. Three pairs of contradicting forces shaping organization are discussed. They include interdependence and coordination, differentiation and integration and relative influence of functional departments and environmental uncertainty. They have a major influence upon intergroup behaviour.

Apparently, all these organizational factors have a major impact upon the efficiency of the inter-group relationship, and thus the efficiency of the R&D/marketing relationship. However, the organization theories concerning inter-group relationship are incapable of dealing with the R&D/marketing relationship in full, since the abstraction of a variety of relationships into an "inter-group" relationship has taken away their original context. Specifically, the effectiveness of the R&D/marketing relationship in relation to the organization's technological conditions and competitive position in the market cannot be appropriately evaluated.

As a result, next, the R&D/marketing relationship is discussed in relation to its technological context. The role of the R&D/marketing relationship or interface is investigated both at the functional level - the R&D management and at the corporate level - the decision-making of firm's technological strategy. Finally, the R&D/marketing relationship is studied from a marketing perspective. It is found that although the marketing literature has largely ignored the technological aspect, several relatively new areas within the marketing literature have demonstrated a strong strategic or technological focus. This provides a great potential for an improved understanding on the R&D/marketing interface from a marketing perspective. These promising areas include (a) strategic marketing, (b) high technology marketing and (3) marketing research for product innovation.

The literature review presented in this chapter shows that the potential for studying the R&D/marketing interface exists at a much larger scale than has been embraced in the previous research. Specifically, an effective R&D/marketing interface is needed in the R&D management to relate technology to the market, in the marketing management to advocate the marketing concept and to implement marketing strategies and in the strategic management to achieve an commercial balance in the strategic portfolio. In other words, while providing a wider theoretical ground for the R&D/marketing interface study, these academic areas will also benefit from such study both theoretically and normatively.

In Chapter 3, "The Theoretical Framework", the role of the R&D/marketing interface will be clearly defined in relation to its technological and market context. On the basis of this literature review and a pilot study described in the next chapter, "The Research Methodology", research propositions are developed which are mainly concerned with the relationships between the strategic role of the R&D/marketing interface, its organizational process and its technological and market environment.

Note

1. Domain similarity refers to the degree to which two different individuals or departments share the same goals, skills, or tasks.

2. The amount of communication reflects the frequency of contact.

3. Communication difficulty refers to the effort required and problems involved in either getting in contact with or in getting ideas across to the other party.

4. Including Mild Disharmony - lack of interaction, etc., Severe Disharmony - lack of appreciation, distrust, etc. and Harmony.

5 . the "marketing philosophers" clearly see marketing both as a function - with prime responsibility for identifying and meeting customer needs - and as a guiding philosophy for the whole organisation. On the other hand, the cluster of "sales supporter" has a restricted view of marketing as sales promotion. In addition, the cluster of "departmental marketers", despite of its strong belief that marketing is about identifying and meeting customer needs, it does not see marketing as a guiding philosophy for the whole organisation.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 INTRODUCTION

The R&D/marketing interface in product innovation has been the key focus of this doctoral research, which is influenced largely by the author's personal interest in technology management stemming from her engineering background. Although the author's relative unfamiliarity with business studies field has brought difficulties in the process of defining more specific research objectives, it has certainly given her a fresh viewpoint without preordained theoretical perspectives or propositions which might bias and limit the findings (Eisenhardt, 1989).

The much needed research inspiration at the early stage was provided by a pilot study in which ten British firms were involved. The development of the research theoretical framework presented in the next chapter has entailed a continuous comparison of the existing literature with findings of the pilot study described in 2.2.

Having defined the specific research objectives, a case study research methodology was decided to be most appropriate. A explanation regarding the choice of such a strategy was given in 2.3. Next the pharmaceutical industry was selected as the research population and four pharmaceutical firms and the total of twelve products developed by these firms were selected as the research sample. Their selection followed certain criteria described in 2.4.

Data collection was the next important step. A big effort was made to ensure the external validity by designing appropriate data collection methods, and multiple data collection methods were used. The triangulation made possible by the multiple data collection methods provided stronger substantiation of constructs and propositions. This is presented in 2.5.

Finally in 2.6, methods of data analysis including both within-case analysis and cross-case analysis were explained. Emphasis of the data analysis was placed on preventing the drawing of premature and even false conclusions as a result of information-processing biases. A general analytical strategy was applied which

relied on the theoretical propositions developed in the theoretical framework. These propositions were concerned with the interrelationships between the strategic constructs, the organizational constructs and the environmental constructs. No special methods were used to measure the organizational and the strategic constructs, and the original qualitative data regarding these constructs were merely summarized by using tables in each innovation case study.

However, the measurement of the environmental constructs was more complicated since several facets were included in one construct. In order to compare the environmental constructs across different cases, a simple management science model - checklists model - that was often used in R&D project selection decision-making was applied to measure the environmental constructs. The suitability of the checklists model in the current research was carefully assessed, where the reasons for using this model were provided.

2.2 THE PILOT STUDY

2.2.1 The Objectives of the Pilot Study

The large scale literature review described in Chapter 1 was conducted at the beginning of this research. The review formed a critical foundation for the development of the research theoretical framework in Chapter 3. For instance, in the review, various dimensions in the R&D/marketing interface were identified and the critical environmental and organizational influences upon the interface were discussed. However, in order to ensure that the research design was not only academically rigorous but also empirically viable and practically relevant, a pilot study was carried out. The main objectives of the pilot study were:

- (a) to decide the more specific research objectives;
- (b) to collect the opinions of practitioners concerning the important factors underlying the R&D/marketing interface;
- (c) to decide the population of the doctoral research.

2.2.2 The Processes of the Pilot study

(1) The Sample Selection

The emphasis of the current research on high technology industry sectors has been underlined in the literature review. According to Traynor (1989), high-tech industry sectors can be defined in terms of their R&D expenditure (see Table 2.1).

TABLE 2.1 TOP TEN HIGH-TECH INDUSTRIES BASED ON R&D EXPENDITURE AS A PERCENTAGE OF SALES
Guided missiles and spacecraft (64%)
Communication equipment and electronic components
Aircraft and parts
Office computing and accounting machines
Ordinance and accessories
Drugs and medicines (16%)
Industrial inorganic chemicals
Professional and scientific instruments
Engines and turbines and parts
Plastic materials and synthetic resins, rubber, and fibbers (%6)
Note: Ranked from highest to lowest. Source: K, Traynor (1989)

In the pilot study, the main criteria for the sample selection were firms within the high-tech sector that carried out technological innovations. As a result, ten firms were randomly selected from various industries within the high-tech sector, and included automation, electronics, communication equipments, chemicals and pharmaceuticals. Data was collected both from published materials and through a total of ten interviews with members of the companies. People interviewed included a Business Strategy Manager of a chemical company, a Vice President of a pharmaceutical company, a Divisional Director of a pharmaceutical company, a R&D Manager of a pharmaceutical company, a Technical Manager of a chemical company, a Product Manager of a Telecommunication company, a Managing Director of a machine tools company, a Marketing Manager of a automation company, a Research

Associate in a biotechnology company and an engineer in a Computer Graphics company (see Appendix 1).

(2) The Interviews

The interviews were carried out over a period of three months, commencing February, 1990. Access to industry was achieved via a variety of sources. For example, the interviews with managers in several pharmaceutical firms were arranged by the supervisor. In addition, the author was able to talk to a number of managers who were attending her Chinese language course at the Warwick University. Also, interviews with a marketing manager in a automation company were carried out while the author was conducting a three months marketing research project for the company.

The interviews were primarily exploratory. Therefore, no standardized questionnaires were used at this stage. Instead, the interviewees were encouraged to talk about anything which they believed to be relevant to the R&D/marketing interface issue. For instance, the first question that was usually posed was "when I mention the term - the R&D/marketing interface, what would come to your mind?". Some of the interviews were also tape recorded with the interviewee's permission. By means of these free style interviews, the author obtained valuable first hand information, which was summarized in 2.2.3. Moreover, the confirmation that the R&D/marketing interface issue was a major concern to the practitioners (hence they were willing to discuss it) was very important and encouraging. Since getting effective access to industry is always a cornerstone in an empirically-based research.

2.2.3 The Outcome of the Pilot Study

The data from the pilot study confirmed the findings from the literature review that the R&D/marketing interface activity was carried out for distinct purposes, and there existed a variation regarding the effectiveness of the interface in product innovation. Furthermore, it was suggested that this variation was possibly related to the stage of product innovation. Dr France, Manager of the Pharmaceutical Development department II, SmithKline Beecham, stated that

"Similar to other departments within R&D, my department, the Pharmaceutical Development Dept. II, has responsibilities in relation to the stages of the drug development process. We organize clinical trials on patients after the new compound's safety profile has been established" (face-to-face interview, 4th March, 1990).

In addition, the link between the variation of the R&D/marketing interface and the type of innovation project was also strongly implied in the study. Dr Li, Research Associate of Biosym Technologies, recalled

"We do have effective communication with them (marketing people) sometimes, especially when a new product idea was generated by them. However, in other instances, we tend to work alone in the laboratory for those highly innovative projects" (face-to-face interview, 7th April, 1990).

Next, the data of the pilot study provided positive evidence of the increased importance of strategic marketing in product innovation. The trend towards internationalization is suggested to be an important attribut.

Moreover, with regard to the research population, data was collected and was compared with the literature review. It was found that although it was theoretically sound to select samples from different industries for the research, it would pose great difficulties to attempt to define measurements for a large group of research variables covering a variety of industries. Therefore, the possibility of selecting a particular industry as the research population was considered. This consideration was then carefully evaluated, when deciding and validating the research methodology and research population, in the following sections.

2.3 CASE STUDY METHODOLOGY

2.3.1 Specific Research Objectives

The Literature review revealed that the synthetic process of the R&D/marketing interface is concerned with the pursuit of competitive advantage by

incorporating negotiated exchange with internal coalitions. This was reinforced by the preliminary findings from the pilot study. Therefore the specific research objectives were defined as below.

- (a) to investigate empirically the role of the R&D/marketing interface in product innovation; and
- (b) to offer theoretical explanations of the tendencies and variations of the R&D/marketing interface in relation to the market, technological and organisational environment as observed in the investigation.

Clearly, the nature of the first objective is either descriptive or exploratory and the second objective is explanatory.

2.3.2 Case Study Strategy

The translation of concepts into operational measurements is a critical step. There are also different research strategies for collecting and analysing empirical evidence. For instance, the survey strategy, the case study strategy, and the experimental strategy. Each has its own advantages and disadvantages. According to Yin (1984), what distinguishes the strategies are three conditions:

- (a) the type of research question posed.
- (b) the extent of control an investigator has over actual behavioural events, and
- (c) the degree of focus on contemporary as opposed to historical events.

The case study strategy has a distinct advantage in a situation where a "how" or "why" question is being asked about a contemporary set of events, over which the investigator has little or no control. It has strength in dealing with a full variety of evidence, such as archives, interviews, questionnaires, and observations. It is a research methodology which focuses on understanding the dynamic present within single settings (Eisenhardt, 1989). It can employ an embedded design, that is, multiple levels of analysis within a single study (Yin, 1984).

Case study research strategy was therefore determined to be most appropriate for our research, which was conducted at two levels of analysis: firm and product. The case studies in the current research were used to provide a description of the R&D/marketing interface process and to generate further explanations or theories regarding this process.

2.4 THE RESEARCH POPULATION AND RESEARCH SAMPLE

2.4.1 The Research Population - the UK Pharmaceutical Industry

The definition of the research population was the next important step following the selection of the research methodology. It specifies the set of entities from which the research sample is to be drawn as well as controls extraneous variation (Eisenhardt, 1989).

In the current research it was decided that the U.K. pharmaceutical firms participating in drug innovation form the research population, and from which the research sample was to be drawn. The criteria of choosing this industry are listed in Table 2.2.

TABLE 2.2 THE CHOICE OF THE PHARMACEUTICAL INDUSTRY

CRITERIA	DESCRIPTION
1. Industry Characteristics (high-tech)	<p>(1) High complexity of drug research and environment;</p> <p>(2) High competitiveness on the basis of innovative drugs.</p> <p>(3) High R&D expenditure.</p> <p>(4) High percentage of labour being employed in the R&D function.</p>
2. Industry Characteristics (peculiarity)	<p>(1) High risk in the R&D investment.</p> <p>(2) Effectiveness of product differentiation as an entry barrier.</p>
3. Outstanding Performance (esp. innovative firms)	<p>(1) Six of the top twenty world's best-selling drugs in 1991 were developed by UK companies.</p> <p>(2) Four of the world's twenty biggest pharmaceutical companies are British</p> <p>(3) UK Pharmaceuticals produced a trade surplus of 1.2 billion in 1991. In the past twenty-five years, the UK pharmaceutical industry has outperformed London stock market by over 400%.</p>

The world-wide ethical pharmaceutical market is approximately £100 billion a year, which is further divided into six major therapeutic sub-markets. These are Cardiovascular, Central Nervous System, Respiratory, Antibiotics/Antiviral, Anti-ulcerants, Anticancer. The U.K. pharmaceutical industry was chosen for investigation because of its high technological characteristics, its high risk in R&D investment, and its outstanding performance over the last ten years, especially within innovative firms. Freeman (1968) argues that the pharmaceutical industry is entitled to more sympathetic understanding of its problems and achievements, and especially of its innovation. An account of the methods of R&D project selection and management in some of the leading innovative firms would be instructive both outside and inside the industry.

The U.K. pharmaceutical industry is a highly competitive industry comprising many firms, some successful, some not so. It is an industry in which firms compete with each other not so much on the basis of price but on the basis of new products. The environmental uncertainty is high. Since a new drug takes approximately twelve years to reach the market, prediction of the future technological and market trends is difficult but critical. Understanding the dynamic pattern of the strategic interactions and the industrial environment calls for a multi-disciplinary approach, the advantage of which has been stated by Porter (1983):

- (a) it is built around a careful re-creation of competitive moves and other events in the sequence in which they occurred;
- (b) it is broad and quite detailed in its coverage of firm behaviour and industry events; and
- (c) it emphasizes the uncertainties present in predicting the future that bear on the decisions facing firms.

It is important to note that as a result of this population selection, findings from the current research will not be generated directly to other industries. Nevertheless, the design of the research theoretical framework presented in Chapter 3 is not constrained to a particular industry, in terms of the research questions posed and the research constructs defined. Therefore with certain adjustments on the measurement of some constructs, the framework should be applicable to other industries.

2.4.2 The Research samples - the Four Pharmaceutical Firms and the Twelve Products

In the case studies research, samples are selected for theoretical rather than statistical reasons. They may be chosen to replicate previous cases, extend emergent theory, or to fill theoretical categories and provide examples of polar types (Eisenhardt, 1989). Pettigrew (1988) notes that given the limited number of cases which can usually be studied, it makes sense to choose cases of extreme situations and polar types in which the process of interest is transparently observable. Based on these principles, four pharmaceutical firms and the total of twelve drug innovation projects are selected. Although the four firms are regarded as successful innovators in the pharmaceutical industry, they

have also suffered product failures. Among the twelve new drug projects studied in this research (three from each firm), three were unsuccessful. These firms are Glaxo, SmithKline Beecham, ICI Pharmaceuticals and Wellcome. These products were developed and launched during different time periods over the past two decades. The criteria for choosing these product samples and their brand names are listed in Table 2.3. It is necessary to note that in order to avoid bias in data collection, decisions on product selection were made independently according to these criteria and the companies did not exert strong influence during this process.

Table 2.3 The Selection of the Products

Company	Brand Name	Criteria
Glaxo	Zantac	1. The strategic importance of the products to the companies.
	Imigran Serevent	2. The novelty of the product features at the time.
SmithKline Beecham	Tagamet	3. The commercial performance of the products.
	Augmentin Eminase	4. The availability of data on each product.
ICI	Tenormin	
	Diprivan Zoladex	
Wellcome	Zovirax	
	Retrovir Lamictal	

2.5 DATA COLLECTION

2.5.1 Reliability of the Data

Research which involves the illustration of historical events has to be handled carefully to ensure its reliability. Some researchers have challenged the reliability of a person's memory of past events. However, it is important to

distinguish between "any past event" and "an important historic event". A person may not remember what he was doing at 11 am. Wednesday the 24th of June, 1976, for example. However, he will certainly recall his wedding day. This kind of memory would be further enhanced if he was repeatedly asked to recall them. The events that we asked our interviewees were similar to the latter. In order to ensure reliability of the data, we applied multiple data collection methods. They include:

- (a) Archives,
- (b) statistic data from industry reports and other sources,
- (c) stock broker reports,
- (d) Interviews: personal face-to-face , telephone follow-up, double-checking, interviewing people who have already left the companies, and
- (e) small scale questionnaire survey regarding the relative value of the facets of a research constructs and the suitability of some of the data analysis measures.
- (e) participating in company meetings and industry project management meetings.

Every interview was carefully prepared by studying background information relating to the company. Most of the companies provided detailed materials about the company and the products beforehand to avoid an unproductive interview. Furthermore, with the aid of these materials, we could monitor the interview and help the interviewees recall past events. By exerting control in this way we intended to extract reliable information.

In addition, a doctoral seminar on advanced methodology in technology management was held by the European Institute of Advanced Studies in Management (EIASM) in May, 1992. Valuable suggestions from a panel including several professors provided additional help in ensuring the validity and reliability of this research.

2.5.2 Data Collection

(1) Technical Information

The relatively well-defined research questions at this stage enabled us to "go into organizations with a well-defined focus - to collect specific kinds of data systematically" (Mintzberg, 1979).

Before starting the detailed research for the main study it was necessary for the author to become familiar with the technical aspects of the products. This was done firstly by scanning the technical literature on the chemistry and pharmacology technologies. This literature was obtained from the companies involved, from periodicals and from the Association of British Pharmaceutical Industry (abpi). Secondly, the author attended the 1990 Annual Meeting of Pharmaceutical Industry R&D Management. Representatives from approximately fifty major UK pharmaceutical companies were discussing at the meeting issues regarding new product development and project management.

(2) Archives

Empirical data on the firms were collected in the period between January, 1991 and July, 1992. It is a particular feature of this industry that firms are extremely secretive and unwilling to disclose data on their activities in case it is of benefit to their competitors.

The author obtained data from secondary sources such as stockbrokers, Datastream, and published materials through BPO (Business Periodical On-line search), etc. Some reports were published by stockbrokers and specialized research companies. Most of these reports were intended for the clients of those companies and were often for restricted distribution. In addition, the author was provided by managers of the companies a number of important documents which were highly valuable to the research. In order to maintain required confidentiality, in the case studies they were briefly referred as company sources, e.g. "Glaxo sources" etc. The author would, therefore, like to express her particular thanks for the way in which this information was made available for the purpose of this academic enquiry.

(3) Interviews

The author has been very fortunate in being able to interview a large number of managers in the firms. Some of them were approached several times. On average, nine people were interviewed in each firm, including both face-to-face and telephone interviews. The names of the interviewers and the date of these interviews are listed in the Appendix 2. Senior Vice President, Directors of Strategic Product Development, Directors of Strategic Marketing, Directors of Product Planning, Product Managers, and R&D Managers were all consulted. A research outline and the covering area of interview together with a covering letter from the Business School were given to each interviewee several days before the interview (see Appendices 3 and 4). Since without a research focus, it is easy to become overwhelmed by the volume of data.

In addition, a large proportion of these interviews was tape-recorded with the permission of the interviewees, and transcripts were generated for some of the interviews. Interviews were free and unstructured and took the form of discussions rather than questions and answers. Most of the critical data on the pharmaceutical firms' R&D/marketing interface were attained through private reports and interviews. The case study reports were sent back to the interviewees for final comments and error correction. The author is greatly indebted to all the people she interviewed. They made possible an in-depth study of what had already been termed a secretive industry.

2.6 DATA ANALYSIS

2.6.1 The Relationship Between the Theoretical Framework and the Data Analysis

Data analysis is the heart of the case studies, but it is both the most difficult and the least codified part of the process (Yin, 1984). Since published studies generally describe research sites and data collection methods, but give little space to discussion of analysis, a huge chasm often separates data from conclusions (Eisenhardt, 1989).

In this research, both within-case analysis and cross-case analysis were carried out by applying a general analytical strategy, which relied on the theoretical propositions presented in the theoretical framework. This guided the case study

analysis with a theoretical orientation and helped focus attention on certain data while ignoring other data. However, although early development of the research propositions is helpful, it is equally important to recognize that they are tentative. Therefore in order to avoid unnecessary data elimination at the early stage of the research, the propositions were developed in such a way that they remained at a relatively general and abstract level to provide the opportunity for the further elaboration at the cross-case analysis where a final verification process was carried out.

Whilst the emphasis was on the cross-case analysis, the within-case analysis was critical in helping us cope with the enormous volume of data. A total of four within-case analyses was presented, each formed a separate chapter and involved detailed case study write-ups of three specific products from one firm. In addition, each product case study write-up was organised under the three research constructs defined in the theoretical framework, i.e. the environmental construct, the strategic constructs and the organisational constructs. An assessment and a preliminary discussion were provided at the end of each product case study. At the end of each chapter a final analysis was conducted, which related the results of the three product case studies within a firm to the research propositions. The idea was to become intimately familiar with each case, while avoiding drawing pre-mature conclusions.

In the cross-case analysis, results from each of the four within-case studies were compared and further analysed. It aimed to reflect some theoretically significant propositions generated in the theoretical framework. The important characteristic of the cross-case analysis is that the final explanation is a result of a series of iterations derived from the individual cases.

2.6.2 The Adoption of Checklist Models for Assessing the Environmental Constructs

(1) The purpose of adopting checklist models

When assessing the constructs at the end of each drug innovation case study, no special assessment methods were used for the organizational and the strategic constructs. The original qualitative information regarding these constructs are merely summarized by using several tables.

However, the measurement of the environmental constructs was more complicated since several facets were included in one construct. In order to explicitly compare between different constructs and across cases, we need measures for scaling various facets that provide a construct conveying a qualitative impression of the whole.

For this purpose, checklist models are considered. In these models, values are given to each facet, which are then added to obtain a total score, as in the example shown in Figure 2.1.

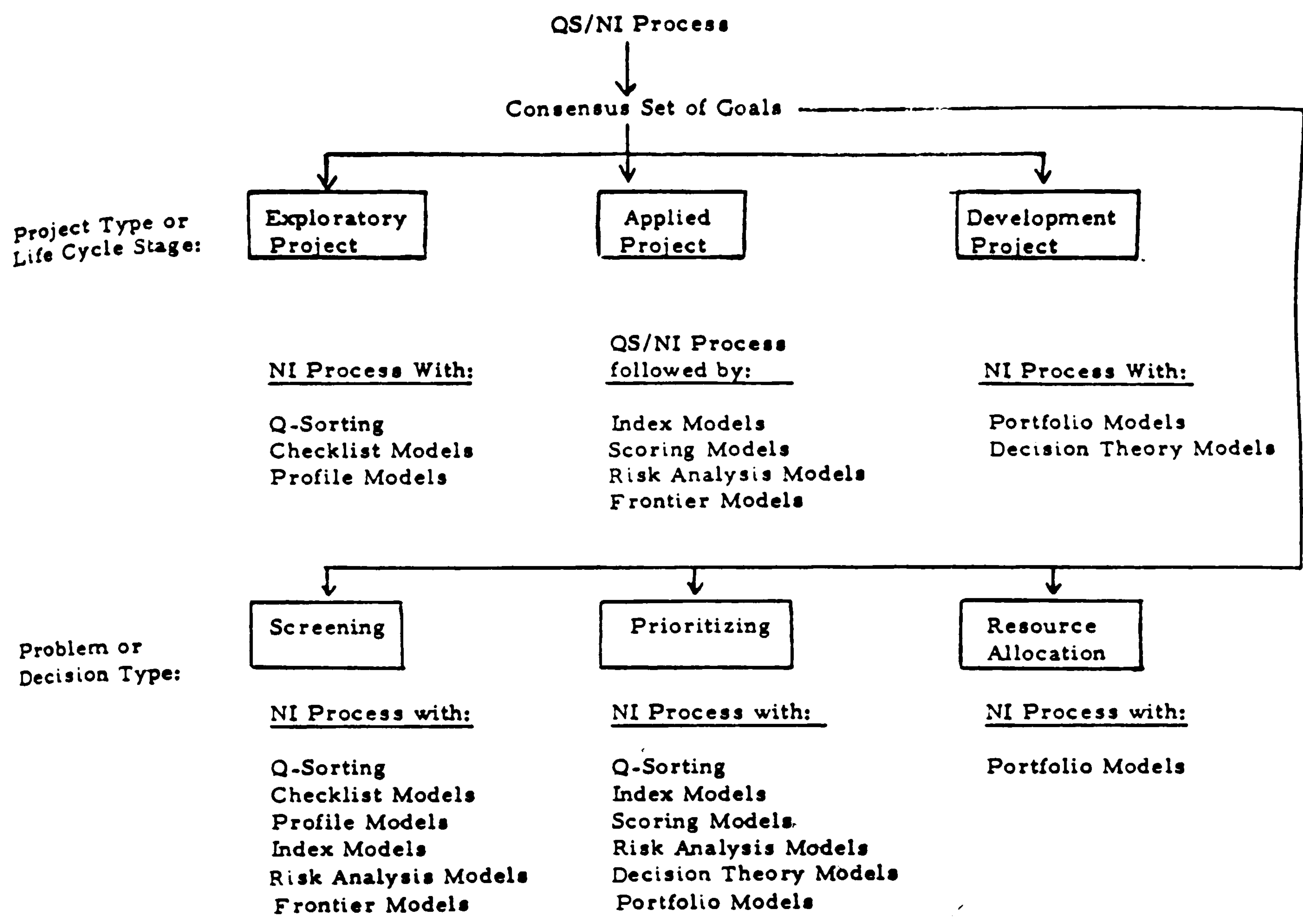
Figure 2.1 An Example of Checklist Model

Construct				
Facet 1	Facet 2	Facet 3	Facet 4	Total Score
1	2	0	0	3

Note: each facet is assigned three different values: 0, 1 and 2.

It is to be noted that checklist models are widely used for evaluating innovation projects at the early exploratory stage (see Figure 2.2), which is also the stage where the assessment of the environmental constructs of this research is based.

Figure 2.2 A Project Selection and Evaluation System



Source: Souder, 1978. pp. 36.

(2) The advantages and limitations of using checklist models

In the current research checklist models are favoured for several reasons. First, the results of checklist modelling are clearly displayed in such a way that the projects can be readily compared and checked against each criterion (Souder, 1978). Second, checklist models help to systematize and standardize judgement

across different cases. Finally, the models introduce objectivity to a qualitative data analysis without changing its qualitative nature. Thus the total score of a construct only summarizes the value of each facet, rather than replacing it. As a result, both the individual value of each facet and the final scores of a construct are displayed clearly in the resulting table.

However, checklist models should be used carefully to avoid unnecessary data elimination and bias. Since checklist modelling applies an equal weighting system, it is extremely important to include information on both individual facets and the summary of their combined effect upon the construct. In addition, checklist models are only suitable for analyzing information at a very early stage of a project; as the project progresses, a scoring model which assigns various weighting to each facet will be more effective in processing and analyzing available information.

Finally, the assessment of the environmental constructs in the twelve innovation cases was sent to the managers of the companies. Their judgements and opinions regarding the suitability of the equal weighting system of the checklists models were also invited (see Appendix 5). Positive responses were obtained. For example, Dr Towler, the Director of the Product Planning department in Glaxo Group Research commented that

"I believe this is a feasible way of evaluating a research project. The factors that we consider when assessing the market and technological risk of a project are similar to what you have used, despite the fact that we do not have such illustrative and explicit measure" (telephone interview, 20th January, 1993).

The detailed application of the checklists models in assessing the environmental constructs in the pharmaceutical industry is presented in the next chapter, "The Research Theoretical framework".

CHAPTER 3 THE RESEARCH THEORETICAL FRAMEWORK

3.1 INTRODUCTION

The research theoretical framework in this chapter is mainly derived from the literature review in Chapter 1. However, the pilot study described in Chapter 2 "The Research Methodology", has also provided useful input. Findings such as the role variation of the R&D/marketing interface according to the customer and R&D sophistication or the driving force of innovation (Souder, 1988; Shanklin & Ryan 1984) suggest that the R&D/marketing interface problems are linked to both internal and external environment of the firm. The theoretical framework is therefore developed to provide a higher level explanation of why these tendencies and variations regarding the R&D/marketing interface are observed.

On the basis of the literature review, the role of the R&D/marketing interface is defined as the pursuit of competitive advantage by incorporating negotiated exchange between the two parties. A multi-disciplinary approach that combines both organizational and strategic aspects of the R&D/marketing interface is thus required.

Having defined the specific research questions in 3.2, three groups of potentially important constructs from the literature are identified in 3.3. They are organizational constructs, strategic constructs and environmental constructs. This priori specification of constructs permits a more accurate and explicit measurement being carried out. In this section six major types of innovation projects are also categorized. Next, in 3.4, research propositions regarding the relationships between the constructs are developed. Finally, in Section 3.5, measurements for the environmental constructs and the innovation performance are developed in relation to the pharmaceutical industry. Since several facets are included in one environmental construct, checklist models are used to combine the numerical values of various facets in one measure. In the current research, each facet is assigned three different numerical values, i.e. 0, 1 and 2. The reasons for adopting the checklist models have been given in the previous methodology chapter.

It is noted that since the development of the theoretical framework is not constrained to the pharmaceutical industry. it should be applicable to other industries once the measurement of some constructs is adjusted.

3.2 RESEARCH QUESTIONS

The specific research objectives have been defined in Chapter 2, "Research Methodology", as follows.

- (a) to investigate empirically the role of the R&D/marketing interface in product innovation; and
- (b) to offer theoretical explanations of the tendencies and variations of the R&D/marketing interface in relation to the market, technological and organizational environment as observed in the investigation.

On the basis of the research objectives, three research questions are specified. They are:

Q1: What is the role of the R&D/marketing interface in product innovation?

Q2: Do the changing technological and market conditions affect the interface role and how?

Q3: How and to what extent does the negotiated exchange process between R&D and marketing affect the fulfilment of the interface role?

These three questions, in the order introduced above, deal with the strategic, environmental and organizational aspects of the R&D/marketing interface respectively.

3.3 RESEARCH CONSTRUCTS

According to the research objectives and questions, three groups of constructs are defined as organizational, strategic and environmental. The identification of these three groups of constructs that are important for the current research is achieved through the extensive literature review presented in Chapter 1. The organizational constructs are identified mainly on the basis of the organizational literature, while the identification of the strategic constructs has received

important input from both the marketing literature and the innovation literature. The environmental constructs are also identified from the innovation literature. Meanwhile, the development of the appropriate measurements for the environmental constructs is accomplished by referring to the operations research and decision theory literature regarding model building. The meaning of these constructs is developed in more detail in this section, while the measurement of these constructs is presented in section 3.5.

3.3.1 Organizational Constructs

The organizational constructs are particularly concerned with the organizational aspect of the R&D/marketing interface, i.e. the negotiated exchange process with internal coalitions. On the basis of the literature review and the pilot study, four important organizational constructs are defined.

(1) Types of the R&D/Marketing Coordination Mechanisms

Three types of coordination have been identified in the organizational literature. They are coordination by standardization, coordination by plan and coordination by mutual adjustment (Thompson, 1967). In addition, there are different integrating devices ranging from integrative departments to an individual integrator, and from permanent cross-functional teams at three levels of management to temporary cross-functional teams (Lawrence & Lorsch, 1967). In this research, the coordination mechanisms and integrating devices in the R&D/marketing interface and the fit of these mechanisms and devices within the diversity of the environment are investigated.

(2) R&D/Marketing Communication Flows

Several studies in the organizational literature have identified the communication between R&D and marketing as a major indicators of the R&D/marketing integration (Ruekert & Walker, 1987). Adopting Ruekert and Walker's definition, the R&D/marketing communication flows include:

- (a) the amount of communication, which reflects the frequency of contact, and

(b) communication difficulty, which refers to the effort required and problems involved in either getting in contact with or in getting ideas across to the other party.

(3) R&D/Marketing Conflict

In the literature (Souder, 1988; Gupta, 1985), conflict between R&D and marketing was frequently reported. The type of conflict varies from mild disharmony to mutual distrust. Although all the conflict has a negative effect upon the R&D/marketing cooperation, the severity of such effect may vary with the types of conflict. Therefore, in the present work the R&D/marketing conflict is measured both in terms of the frequency and the type of conflict.

(4) Relative Influence of the R&D and Marketing (RIRM)

Various authors in the organizational literature (Lawrence & Lorsch, 1967; Turner & Giles, 1981; Festinger, 1954) have stressed the relationship between the relative influence of the functional departments and environmental uncertainty. They maintain that the groups that possess the most appropriate skills and the information to cope with the critical uncertainty come to have stronger influence.

In addition, it is found in both the literature (Souder, 1988; Moenaert, 1992) and the pilot study that the R&D/marketing interface problems resulting from one party dominance seem to be strongly associated with the types and the stages of innovation. However, the weakness of the existing studies is the lack of understanding of the interface for each of the innovation cycle stages (Moenert, 1992).

In order to investigate the relationship between the R&D/marketing interface activity and the stages of innovation, the relative influence of R&D and marketing in relation to these stages is defined as an important measurement for the organizational construct.

Two distinctions are made in the present work. One is between a "market-initiated" and a "market-driven" project, another is between a "research-initiated" and "a research-driven" project. The term "market-initiated" or "research-initiated" is only concerned with the source of the new idea.

However, the term "market-driven" or "research-driven" is related to the driving force of a innovation project. "Marketing-driven" refers to a process where marketing has a strong influence. Similarly, "research-driven" refers to a process which is dominated by research considerations. However, it is important to note that a project is not necessarily driven by only one force during the entire product development process.

3.3.2 Strategic Constructs

The strategic constructs are specifically related to the strategic role that the R&D/marketing interface plays in product innovation, i.e. the pursuit of competitive advantage. In the marketing literature two dimensions and two levels of the interface, i.e. the product dimension and the market dimension, and the corporate level and the project level, have been assessed. In addition, the importance of marketing research in assisting both strategic and technical decision-making during the innovation process is emphasized (More, 1984; Rosenberg, 1989). Meanwhile, in both the innovation literature and the strategic management literature, a technological dimension at corporate level is identified (Meyer & Robert, 1988; Pavitt, 1986). The presence of these dimensions of the R&D/marketing interface is reinforced by the results of the pilot study. Thus, on the basis of both the literature review and the pilot study, the strategic role of the R&D/marketing interface is defined to cover five dimensions.

(1) The Corporate Strategic Dimension

The interface provides vital input for the formulation of business strategy with respect to the identification of market opportunities over the firm's strategic time horizon;

(2) The Corporate Technical Dimension

The interface provides critical input for the formulation of firm's technology strategies with respect to the evaluation of external technological trend and internal technological competence;

(3) The Product Strategic Dimension

The interface is responsible for deciding a price strategy, product positioning strategy or promotional strategy for a specific product;

(4) The Product Technical Dimension

The interface is concerned with the maximization of the design characteristics of the product that are valued by customers;

(5) The Operational Dimension

The interface is concerned with the application of appropriate marketing research, such as an examination of market statistics, visits to potential customers, field tests of prototypes and test marketing, to provide required information for either strategic or technical purposes.

These five dimensions are illustrated in Figure 3.1.

Figure 3.1 Five Dimensions of the R&D/Marketing Interface

	Corporate	Product
Strategic	CSD	PSD
Operational	OD	
Technical	CTD	PTD

3.3.3 Environmental Constructs

In the literature review, both the technological environment and market environment facing product innovation are discussed. Six blocks of variables are suggested to be the major determinant of new product outcomes (Calantone & Cooper, 1981). They include (a) the commercial entity of the new product,

(b) the nature or quality of information acquired, (c) nature of the marketplace, (d) proficiency of process activities, (e) the compatibility of the resource base of the firm and (f) nature of the project. It is apparent that the first three blocks are concerned with either firm's marketing proficiency or the market condition, while the remaining three blocks are related to either firm's technological strength or the technological environment.

In addition, Cooper (1978) emphasizes that the primary criteria against which a research program must be judged should include (a) impact, (b) feasibility with respect to technological risk, technical competence, and management effectiveness and (c) research merit such as research opportunity and technical strength. Similarly, Moenaert (1992) proposes a crucial link between the task uncertainty of a project and the market and technological environment. Based on these theoretical and empirical studies, three environmental constructs and a series of facets for these constructs are identified. These constructs and their facets are

(1) Marketing Uncertainty: Market Newness, Market Size, Customer Need Awareness and Market Competitiveness;

(2) Technological Uncertainty: Nature of Project, Technological Newness and Product Complexity; and

(3) Internal Marketing and Technological Strength: Marketing Experience and Expertise, Research Experience and Expertise, Development Experience and Expertise and Company Reputation.

The facets of each of the three environmental constructs are defined in more detail when they are adjusted to the situation in the pharmaceutical industry in section 3.5.

3.3.4 Types of Innovative Project

On the basis of Calantone and Cooper's (1981) product classification described in the literature review, in the current research, the twelve drug innovation projects are categorized into six major types according to their closeness to the firm's existing market and technology and their newness to the industry. This is specially useful when comparisons are made and characteristics are discussed

between different drug innovation cases in the cross-case analysis in Chapter 9. The six major types of innovative projects are

- (a) the "related-technology and existing-market" type of product;
- (b) the "related-technology but new-market" type of product;
- (c) the "unrelated-technology but existing-market" type of product;
- (d) the "unrelated-technology and new-market" type of product;
- (e) the "new-technology but existing-market" type of product;
- (f) the "new-technology and new-market" type of product.

Clearly, the types of innovation project are associated with the three environmental constructs identified in this section. For instance a "related-technology and existing-market" type of project has lower market and technological uncertainty and higher internal expertise compared with the other three types of project. Meanwhile an "unrelated-technology and new-market" type of project is different from a "new-technology and new-market" type of project in that the former generally involves higher market competitiveness while the latter involves higher technological uncertainty.

3.4 RESEARCH PROPOSITIONS

Having defined the research constructs, three propositions are offered relating to the three questions specified in 3.3. i.e.

Q1: What is the role of the R&D/marketing interface in product innovation?

Q2: Do the changing technological and market conditions affect the interface role and How?

Q3: How and to what extent does the negotiated exchange process between R&D and marketing affect the fulfilment of the interface role?

Proposition 1 (addresses Q1): the R&D/marketing interface plays important role in one or more of the five dimensions, during one or more of the five stages of product innovation.

Proposition 2 (addresses Q2): the changing technological and market conditions that are specified in the environmental constructs affect the interface role both in terms of the interface needs and the interfacing difficulties.

Proposition 3 (addresses Q3): the extent to which the interface role is fulfilled depends on the appropriateness of the coordination mechanism, the effectiveness of communication, the relative influence of R&D and marketing and the type of interface conflict.

3.5 MEASUREMENT OF THE RESEARCH CONSTRUCTS IN RELATION TO THE PHARMACEUTICAL INDUSTRY

While the organizational and strategic constructs defined in Section 3.4 remain consistent across industries, the environmental constructs need to be adjusted to reflect the circumstances in the pharmaceutical industry. Moreover the measurement of the environmental constructs is more complicated since several facets are included in one construct. Because of the need to compare the total score of an environmental construct between different cases, checklist models have been adopted to combine the numerical values of the many facets of a construct in one measure. The reasons have been provided in the methodology chapter.

In this section, each facet is assigned three different numerical values, i.e. 0, 1 and 2. A score of 0 and a score of 2 represent the two ends of a spectrum, such as high and low, big and small, and so on. While the score of 1 characterizes a moderate degree, such as medium, average and so on. This procedure follows an accepted methodology of item scaling, assigning numerical values to an object in such a way as to measure its properties (Guilford, 1954). It is necessary to note that the numerical values of a facet need not to be formulated in the zero-one-two fashion as used here. Various distributions over the performance space have been used in the literature (Baker & Moore, 1969). However, approaches using too many scores were found to introduce an unwarranted overspecification, as well as lead to unjustifiable complexities. Two or three different degrees of conformance were considered to be reasonable (Souder, 1972).

3.5.1 Adjustment of the Environmental Constructs to the Pharmaceutical Industry

(1) Market Uncertainty

Four facets have been defined in the market uncertainty construct. These are (a) Market Newness, (b) Market Competitiveness, (c) Customer Need Awareness and (d) Market Size. The description of these facets in relation to the pharmaceutical industry and their scaling are presented below.

(a) Market Size, the estimated size of the target market of the drug. Situation 1 (S1): big. Situation 2 (S2): medium. Situation 3 (S3): small.

(b) Market Newness, the newness of the drug's target market. Situation 1 (S1): the market is new to both the company and the customers. Situation 2 (S2): the market is new to the company, although established to the customers. Situation 3 (S3): the market is established to both the company and the customers.

(c) Consumer Attitude and Customer Need Awareness, the consumers' attitude toward the new drug and their need awareness in the drug's target market. Situation 1 (S1): high. Situation 2 (S2): average. Situation 3 (S3): low.

(d) Market Competitiveness, the intensity of the competition in the drug's target market. Situation 1 (S1): high. Situation 2 (S2): average. Situation 3 (S3): low.

(2) Technological Uncertainty

The technological uncertainty constructs refer to the Nature of Project, Technology newness and Product complexity. In the pharmaceutical industry, the nature of a new drug project is largely determined by the nature of the disease that the drug is aimed, specifically, the cause of the disease. Since it determines the level of new knowledge required for achieving the project goal. Meanwhile, the newness of technology is associated with the mode of action of the drug. A novel mode of action requires exploration of new scientific approaches and knowledge. Finally, the product complexity is reflected by the

severity of the side effects of the drug. Thus, the three facets of the technological uncertainty construct and their scaling are defined as follows.

- (a) Cause of Disease, the cause of the disease that a drug is being developed to treat. Situation 1 (S1): clear. Situation 2 (S2): partly known. Situation 3 (S3): not clear.
- (b) Mode of action, the mode of action of the drug being developed, in terms of the drug's chemical structure and mechanism. Situation 1 (S1): new. Situation 2 (S2): partly new. Situation 3 (S3): minor improvement.
- (c) Side Effect, the side effect of the drug that is shown after launch. Situation 1 (S1): high. Situation 2 (S2): average. Situation 3 (S3): low.

(3) Internal Marketing and Technological Strength

The internal marketing and technological strength constructs consist of four facets. These are (a) Marketing Experience, (b) Research Experience, (c) Development Experience and (d) Company Reputation. According to the circumstances in the pharmaceutical industry, the four facets and their scaling are further defined as below.

- (a) Marketing Experience, the marketing experience and expertise and of the company in the target market of the new drug. Situation 1 (S1): experienced. Situation 2 (S2): some experience. Situation 3 (S3): inexperienced.
- (b) Company Reputation, the reputation of the company in the drug's targeted therapeutic market. Situation 1 (S1): good. Situation 2 (S2): average. Situation 3 (S3): not established.
- (c) Research Experience, the research experience and expertise of the company in the research area that the drug is being developed. Situation 1 (S1): experienced. Situation 2 (S2): some experience. Situation 3 (S3): inexperienced.
- (d) Development Experience, the development experience and expertise in both clinical trials and registration of the new drug. Situation 1 (S1): experienced. Situation 2 (S2): some experience. Situation 3 (S3): inexperienced.

3.5.2 Measurement of the Environmental Constructs Using Checklist Models

As noted earlier, checklist models have been used in the current research to combine the numerical values of the many facets of a environmental construct in one measure. Each facet is given three different degrees of numerical values: 0, 1, 2. The scores of the facets of a construct are then added to obtain a total score for the construct. This total score can be further divided by a possible score to obtain a relative score. The possible score for both market uncertainty construct and internal technological and marketing strength is 8 (four facets, each has a maximum value of 2), and for technological construct is 6 (three facets, each has a maximum value of 2). The measurement of the three environmental constructs is illustrated in Tables 3.1 to 3.3.

Table 3.1 Measurement of the Market Uncertainty Using Checklists Method

Market Uncertainty											
Market Size			Market Newness			Customer Need Awareness			Market Competitiveness		
S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
0	1	2	2	1	0	0	1	2	0	1	2

Table 3.2 Measurement of the Technological Uncertainty Using Checklists Method

Technological Uncertainty								
Cause of Disease			Mode of Action			Side Effect		
S1	S2	S3	S1	S2	S3	S1	S2	S3
0	1	2	2	1	0	2	1	0

Table 3.3 Measurement of Internal Technological and Marketing Strength Using Checklists Method

Marketing Experience			Company Reputation			Research Experience			Development Experience		
S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
0	1	2	0	1	2	0	1	2	0	1	2

3.5.3 Measurement of The Drug Innovation Performance

To evaluate performance systematically, managers need to decide what to measure. Cordero (1990) proposes that performance should be measured both in terms of the resources and outputs. Outputs should be measured to determine whether they help accomplish objectives (effectiveness); resources should be measured to determine whether minimum amounts are used in the production of these outputs (efficiency). Measures to evaluate the innovation performance which are relevant to the project level are summarized as follows.

- (a) Business Opportunity - the monetary value of the total market created by technical outputs. It is useful for comparing the market potential of different technical outputs.
- (b) Research Intensity - percent of sales allocated to the research and development of a particular innovation project.
- (c) Time Span of Technological Innovation - the time it takes between the conception of an innovation and its introduction into marketplace.
- (d) Innovation Output weighted by its importance
- (e) Percentage of new product sales

In the pharmaceutical industry, the average return on investment is approximately 6.1% (Joglekar and Paterson, 1986). However, less than one in five new drugs attain this average return during a 15 years sales period. Since at the time a firm decides to invest in R&D for an NCE, it cannot know how successful the NCE will be, it is assumed that each marketable NCE incurs the

average R&D cost or research intensity, which is approximately £80 - 100 million. Because each marketable NCE incurs the average R&D cost or research intensity, the absolute as well as the percentage of sales of a marketable NCE reached during a certain period of time become the important indicators for the NCE's commercial success.

Therefore, in the current research, three measures are used to evaluate the performance of drug innovation. They are:

- (a) Sales of the new drug - the absolute and/or the percentage of the new drug sales will be measured to evaluate the commercial return of the drug innovation;
- (b) Development Speed (DS), which is used to measure both the time resources needed to obtain marketable outputs and the firm's ability in fast development.
- (c) Innovative Level of the drug innovation, which is used to measure both the technical resources needed to obtain marketable outputs and the firm's ability in producing innovation output of high importance. The innovative level of a new drug is shown in Table 3.4.

Table 3.4 The Innovative Levels of the New Pharmaceutical Products

Levels	Description
Me-Too	Drugs that offer no benefits over existing drugs and have no therapeutic advances (have an identical mechanism of action).
Innovative	Drugs that have significant advantages over existing therapies, and in some cases will be so novel as to be the first in their respective classes. They are further divided into four groups:
High	1. biotechnology-derived products. 2. new classes of drugs, 3. novel agents in established classes, 4. early entrants in a new class,

Source: Medical Marketing & Media, August 1991.

3.6 SUMMARY

The research framework presented in this chapter is attempted to offer a higher level explanation of the tendencies and variations regarding the R&D/marketing interface by applying an inter-disciplinary approach. It is developed on the basis of the literature review and the pilot study.

The research is based on the premise that the objective of the R&D/marketing interface management is the pursuit of competitive advantage by incorporating negotiated exchange process between these two coalitions. Three questions are specified in this chapter which deal with the strategic aspect, environmental aspect and organisational aspect of the R&D/marketing interface respectively. By addressing these questions, the research will investigate the relationships between the organizational, strategic, and environmental constructs of the R&D/marketing interface in product innovation.

The identification of these three groups of constructs is achieved through the extensive literature review presented in Chapter 1 and the pilot study discussed in Chapter 2. The organizational constructs are particularly concerned with the organizational aspect of the R&D/marketing interface - the negotiated exchange process with internal coalitions. They are defined as:

- (a) Types of the R&D/Marketing Coordination Mechanisms
- (b) R&D/Marketing Communication Flows, i.e. the amount of communication and communication difficulty.
- (c) R&D/Marketing Conflict which refers to the frequency and the degree of conflict between these two parties.
- (d) Relative Influence of the R&D/Marketing Interface

The strategic constructs are specifically related to the strategic role of the R&D/marketing interface in product innovation - the pursuit of competitive advantage. They are defined as:

- (a) the Corporate Strategic Dimension (CSD)
- (b) the Corporate Technical Dimension (CTD)
- (c) the Product Strategic Dimension (PSD)
- (d) the Product Technical Dimension (PTD)

(e) the Operational Dimension (OD)

The environmental constructs are designed to reflect both external market and technological uncertainties facing product innovation and internal marketing and technological strength. They are:

- (a) Market Uncertainty: Market Newness, Market Competitiveness, Market Size and Customer Need Awareness.**
- (b) Technological Uncertainty: Nature of Project, Product Complexity and Technology Newness.**
- (c) Internal Marketing and Technological Strength: Marketing Experience, Research Experience, Development Experience and Company Reputation.**

The innovation projects are categorized into six major types on the basis of the literature. The six major types of innovative projects are (a) the "related-technology and existing market" type of product, (b) the "related-technology but new-market" type of product, (c) the "unrelated-technology but existing market" type of product, (d) Type D is the "unrelated-technology and new-market" type of product, (e) the "new-technology but existing-market" type of product and (f) the "new-technology and new-market" type of product.

Next, the environmental constructs are adjusted to reflect the circumstances in the pharmaceutical industry. The measurement of the environmental constructs is more complicated since several facets are included in one construct. Checklist models are adopted to combine the numerical values of the many facets of a construct in one measure. The reasons for using these models have been provided in the methodology chapter. Each facet is assigned three different degree of numerical values, i.e. 0, 1 and 2. In addition, three measures to evaluate drug innovation performance are derived from the literature with some adjustments to the circumstances in the pharmaceutical industry. They include the absolute and/or the percentage of the new drug sales, the development speed and the innovative level of the drug innovation.

The research proposes that the R&D/marketing interface plays an important role in one or more of the five dimensions during one or more of the five stages of product innovation. Moreover, the interface needs and difficulties in these

dimensions are postulated to be directly related to the changing technological and market conditions of the organization. The research also hypothesizes that the extent to which the interface roles are fulfilled depends on effectiveness of the negotiated process with internal coalitions. These propositions will be tested against case evidence provided in twelve drug innovation cases, which have taken place in four pharmaceutical firms. This verification process is presented in both the within-case analysis conducted in Chapter 4-7, and in the cross-case analysis in Chapter 8.

CHAPTER 4

THE PHARMACEUTICAL INDUSTRY BACKGROUND

4.1 INTRODUCTION

The pharmaceutical industry has been involved in a rapidly changing environment, which has had a profound effect upon its organization and product line. Starting from the 80s, many new product possibilities emerge as a result of research in such areas as molecular biology, brain chemistry and immunology. On the other hand, the business environment is dominated by regulation and legislation designed to benefit various segments of society, which leads to more generic prescribing, increased substitution, more price control, and escalated R&D cost (Faust, 1984). In the market place, consumer attitudes towards medication are also changing. Consequently, the success of each firm depends on the capability of the firm to respond to this challenging environment.

The pharmaceutical industry is a high technology industrial sector. It also has several unique characteristics in terms of customers, products, regulation and R&D, which are not shared with other industries. The most distinct feature of this industry is the co-existence of two layers of customers. They are doctors and patients. The situation is unique because

- (a) these two groups of customers do not belong to same economic unit;
- (b) doctors who are the decision makers do not consume the products;
- (c) neither the doctors nor the patients pay for the cost. Instead, it is paid by the National Health Service (NHS).

Moreover, in the pharmaceutical industry, drug innovation is a highly ethical issue since human health and safety are concerned. As a result, government regulation regarding the safety and efficacy of a pharmaceutical product is strongly enforced upon the companies, which touches on all elements of the marketing mix, pricing, advertising, distribution, and new product development.

Drug innovation is a major competitive weapon in the pharmaceutical market. Despite of the huge R&D cost (estimated at £100 million per drug) and the extremely high risk in drug R&D, pharmaceutical companies continue to invest heavily in R&D. It is notable that in the past decade the "blockbusters" have accounted for an increasing proportion of the market, which implies that companies are relying on "blockbusters" even more than before. For instance, in 1985, the world's best-selling drug, Tagamet, achieved sales of £450 million. However, five years later in 1990, the world's best-selling product, Zantac, generated revenues approaching £1,600 million, which were three times Tagamet's 1985 total. Consequently, as big-selling drugs become bigger, it becomes increasingly difficult to achieve comparable size from sales in one market and international marketing scale becomes critical.

Traditionally, in the pharmaceutical industry, discoveries of new innovative drugs were the major drive for the fast growth of the industry. As a result, R&D as the source of such new products, overshadowed all other departments in the company including the marketing department (Corstjens, 1991). However the situation is changing with the rapidly changing environment, more sophisticated marketing techniques are applied and closer interaction between the R&D and the marketing departments of a firm is emphasized.

This chapter is intended to provide necessary background information for the case studies presented from the next chapter, "The Glaxo Case". In 4.2 knowledges regarding the pharmaceutical industry regulation and patent law are introduced. Next, the market and competitive situation of the industry is described in 4.3. In 4.4 issues regarding pharmaceutical technologies and innovation are raised. Next In 4.5 the status of the R&D/marketing interface in the pharmaceutical industry is discussed. Finally the performance of the U.K. pharmaceutical industry is evaluated in 4.6.

4.2 GOVERNMENT REGULATION AND PATENT LAW

4.2.1 Government Regulation

In the pharmaceutical industry, governments all over the world have a dual role to play: to provide the incentives to encourage Research and Development activity in order to discover new therapeutic advances for the benefit of the

mankind, yet at the same time to reduce the cost of drugs to health authorities and to control the level of profitability in the industry.

In order to fulfil government requirements, pharmaceutical companies have to submit extensive clinical and toxicological data to government bodies, first before a compound is allowed to be progressed to the human testing stage, and then before a drug is allowed to be launched on the market. Safety and efficacy of the drug are the two main criteria for the approval of the drug. The drug approval process has become more rigorous and more time consuming. As a result, the development part of the R&D has become more expensive over the last two decades. In 1970 approximately 50% of total R&D resources were spent on development, however, by 1990 this figure had risen to more than 70% (Bartling & Hadamik, 1982).

The heterogeneity of the approval procedure of governments across the world leads to rather difficult situations for the drug companies. One of the most ambitious targets of big multinational pharmaceutical companies like Glaxo, SmithKline Beecham, etc. is to gain simultaneous approval for its important new products in all the world's major countries. This requires high level of coordination amongst all the functions within the company.

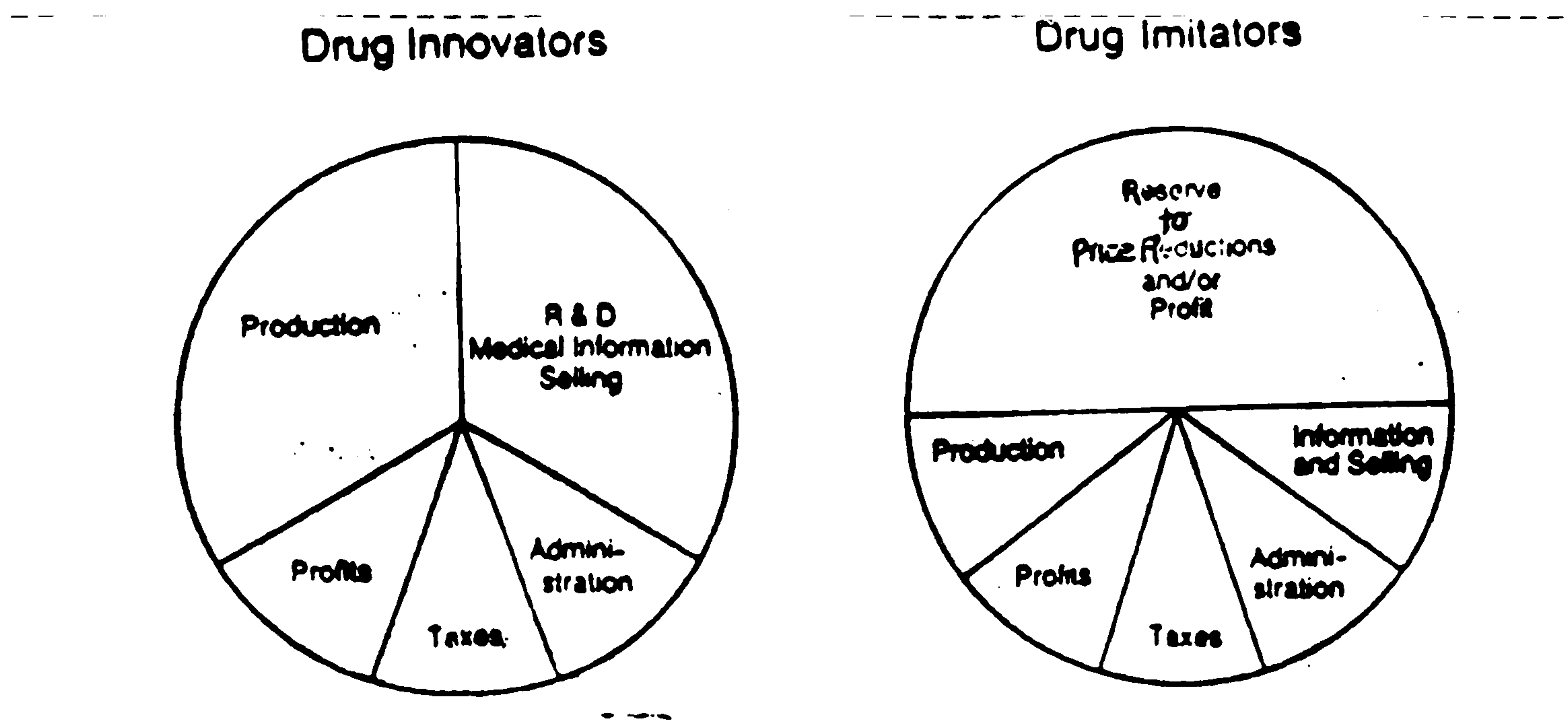
The price of prescription drugs is controlled by government in most developed countries. In the UK, the government does not set prices for individual drugs, instead, it controls the total return on capital employed on the company's product line. In 1983, the industry's target rate of return was reduced from 25% to 17%. Nevertheless, price controls tend to affect old drugs rather than new drugs. Therefore new and more expensive drugs are frequently launched to replace the less profitable old drugs.

4.2.2 Patent Law

The fundamental consideration for the establishment of a patent system was the recognition of the economic value of ideas (Jucker, 1990). In the last two decades, the tendency has clearly been towards increasing the strength of patent protection. The major development has been the bringing into force of the European Patent Convention. It provides for a term of patent protection of twenty years from the first application date. Patent and drug research are closely

related in such way that patents provide protection and incentive for the drug research. Patents also have an influence on the structure of drug prices, however this influence does not necessarily result in higher drug prices (Jucker, 1990). Rather, the cost of research and development is the major source of the drug price. Figure 4.1 shows the cost structure of the drug innovators and that of the drug imitators.

Figure 4.1 The Comparison of Cost Structure Between Drug Innovators and Drug Imitators



Source: Jucker, 1990). . pp. 72 .

The extremely long duration of drug research and development (approximately 10-12 years) on the one hand, and the need for early patenting on the other, which is derived from the very nature of the drug research, indicate that the effective life of drug patents is in fact quite short in comparison with other technical areas. Once a drug is off patent, it faces intense competition from generics, which are much cheaper than the original brand, as they do not have heavy R&D investment burden.

There has been a major threat to a significant number of the best-selling drugs in the form of patent expirations. According to BZW Research (Medical

Marketing & Media, August, 1991), 22 of the top-50 products of 1989 will lose their patent protection in the U.S and other major markets in five years time and they could be vulnerable to generic competition. These drugs include Zantac (Glaxo), Capoten (Bristol-Meyers Squibb), Tagamet (SmithKline Beecham), Tenormin (ICI), Voltaren (Ciba-Geigy), Adalat (Bayer) and Ventolin (Glaxo).

Government regulation and patent law also have important implications for the scope of pharmaceutical marketing actions. Regulatory affairs become another important aspect of the marketing activity in product innovation apart from the strategic aspect and technical aspect of the activity. Advertising of prescription drugs to the general public is prohibited for ethical reasons and market testing is very difficult and restricted since human beings are involved. In particular, a market testing or clinical trial testing for a new drug targeting at a complex or life threatening disease has to be carried out in combination with a existing drug to ensure that the quality of the treatment on a patient is not affected by such testing. This regulation has a profound impact upon drug research and marketing. On one hand, it provides any drug that enters market first with a significant competitive advantage of being the first-line treatment. On the other hand, it becomes an effective barrier to competitive entry.

4.3 MARKET STRUCTURE AND COMPETITION

4.3.1 Market Structure

The pharmaceutical market is divided into ethical pharmaceuticals and over-the-counter medicines. In the ethical pharmaceuticals market, there are two types of product, patent-protected brands and generics. The former compete mostly on non-price benefits, such as therapeutic value, and the latter are generally driven by price competition. As generic products do not have large scale R&D activity, our research will focus on the patent-protected brand market.

As noted earlier, the sales of prescription drugs is not based on the choice of consumers but rather on that of doctors. Because the decision on a purchase is primarily influenced by the drug's effectiveness in treating the disease rather than the drug's price, the prescription market has relatively low price sensitivity.

Inertia exists in prescribers' behaviour, resisting a switch away from trusted brands. Thus, company reputation in a market segment or a therapeutic area is an effective marketing tool in the pharmaceutical market.

According to Smith (1988) the consumer behaviour in the pharmaceutical market is distinct at different stages of product life cycle. At the introduction stage, the market for a new product will be comprised of a small percentage of the medical population that is normally the first to try new drugs, and who is influential with their colleagues. The introduction of a new product can be relatively smooth, if success has been achieved by any previous efforts in this product class. However, for a new product that is a radical departure from traditional therapy, enormous education effort is required to familiarize the general public, as well as the doctors with the new product concept. Marketing costs will reflect the special nature of promotion to stimulate primary demand. A new product is at its highest price upon its introduction. This reflects both the lack of direct competition and the uncertain sales future. Even at this highest price, in the face of high production and marketing costs and with the build up of past research and development costs, management may plan on operating at a loss on the product during the introductory stage.

Once the product has survived successfully the introduction stage, it will get wider acceptance. In the meantime, the number of competitors will begin to increase. The price of the product will tend to go down because of the increased sales and increased competitors. The promotion activities are no longer towards the benefits of the product class, but the advantage of the product itself, in comparison with competitors' products.

During the maturity stage competition reaches its peak. The total sales of the product class, which have been rising through the early stages, continue to increase, but at a decreasing rate. Price competition is intensified.

Saturation marks the point at which the drug product has been tried and used for all feasible indications. The number of competitors stabilizes. The decline of a product class is mostly related to the effectiveness of the product as compared to other means of therapy - result from new product development.

4.3.2 Competition

The pharmaceutical industry is a highly profitable and thus attractive industry for potential newcomers. However there exist substantial barriers to entry. Corstjens (1991) concludes three potential entry barriers: patents, Research and Development (R&D) investments, marketing investments and company reputation. In addition, it is important to note that product differentiation is another effective entry barrier. In 1984, there were 2,100 branded products which in turn generated 3,900 formulations in the UK (Prentis & Walker, 1988). Product reformulations in the pharmaceutical industry, such as new dosage form or new delivery system, involve the genuine solution of difficult scientific or technical problems. It therefore acts as an effective entry barrier to competitors.

The degree of concentration in the drug industry can be studied at three different levels: the total world pharmaceutical market, the therapeutic areas, and the product. The degrees of concentration at these three level are significantly different. Overall, the industry remains very fragmented. For example, in 1990-91, the top three companies, Merck, Glaxo, and SmithKline Beecham, together controlled only about 9% of the total market (abpi estimation). However, the characterization of the industry as being fragmented is somewhat deceptive, when one turns to the second level, that of therapeutic area. For instance, the top three manufacturers of cardiovascular drugs, Merck, Bristol-Meyer Squibb and ICI controlled about 40% of the therapeutic market (abpi estimation). At the level of individual products, the degree of concentration becomes very high. For example, Glaxo's anti-ulcer drug, Zantac, accounts for 50% of the total anti-peptic ulcer market. This can lead to very skewed sales concentration within companies, with large percentages of their total sales resulting from only one or a few brands. Zantac, launched in 1981, with the sales figure of £1,600 million in 1991, is responsible for more than half of the company's total sales (Glaxo sources).

A number of mergers is currently reshaping the internal rivalry among pharmaceutical companies. In 1989, SmithKline, an American company forged a merger with Beecham, a UK based company. The newly merged pharmaceutical giant, with sales of £3 billion became the world's third biggest pharmaceutical company in 1990. Other mergers were between Squibb and

Bristol-Myers, Merril Dow and Marion Laboratories, and Rhone-Poulenc and Rorer. The major reason for this merger drive seems to be the creation of a critical mass to cope with escalated R&D investment under intensified world-wide competition and stringent government regulation.

4.4 PHARMACEUTICAL INNOVATION AND RISK AND RETURN IN PHARMACEUTICAL R&D

4.4.1 Pharmaceutical Technology

Technology plays a crucial role in the industry growth and market evolution. A wide range of effective new medicines becomes available as a result of scientific discoveries at different times in history. In the past fifty years, the pace of scientific advance in drug development has increased, 95% of the medicines available today was unknown in 1950. Most innovations have been made in the laboratories of pharmaceutical companies (Jucker, 1990). The levels of innovation and the diffusion rate of innovation are increasing. It is reported by the Medical Marketing & Media (August, 1991) that the more recent the introduction of innovation, the more rapid has been the rise to prominence. The five new entrants to the world's top 50 in 1986 took an average 4.8 years from first marketing to attain top-50 status, in 1990, the average time was just 2.7 years. Comparing each new entrant to the world's top-50 drugs between 1981 and 1985 with that during a similar period between 1985 and 1990, increased levels of innovation in the latter period can be found. Whilst only one of the nine new entrants to the top-50 drugs in 1985 had a high innovative level (Glaxo's Zantac, second entrant to a new class), all the eleven new entrants to the top-50 drugs in 1990 were innovative (first drug in the class, new agent in an established class, and so on).

Pharmaceutical research and development are crucial in this new-product race by discovering or applying scientific approaches to develop new substances. Scatter-gun approach is a traditional approach in the pharmaceutical research. It starts from new synthetic variations on familiar chemical compounds and to investigate their effects. This approach is very cost inefficient due to its trial-and-error nature (Corstjens, 1991). More recently a rational approach is applied. It starts off with a hypothesis about the etymology of the targeted disease. Via a

receptor or an enzyme, one tries to develop chemical substances that can selectively modify the targeted disease (Johnson, 1987).

In addition, instead of testing in animals, receptor technology is invented to screen compounds in test tube. It allows researchers to determine quickly whether a compound is active in the human body and where it acts by using cell membrane receptors isolated from organs (Siegelman, 1989).

The most recent development is the application of biotechnology in drug research. Biotechnology refers to techniques for manipulating micro-organisms for human benefit. This knowledge of the genetic code has allowed the determination of the composition and structure of proteins. Since proteins perform most of the necessary functions in any living cell, understanding them has been the key to unlocking a whole host of information about living processes.

Meanwhile, techniques to develop new drug delivery systems are explored. They allow a drug to be taken more conveniently or more effectively, which can be used to stretch out the patent lives of current drugs. For instance, a new system to deliver a biotechnology drug orally, which has not been possible because biotechnology drugs break down in the digestive system, will be the big medical breakthrough.

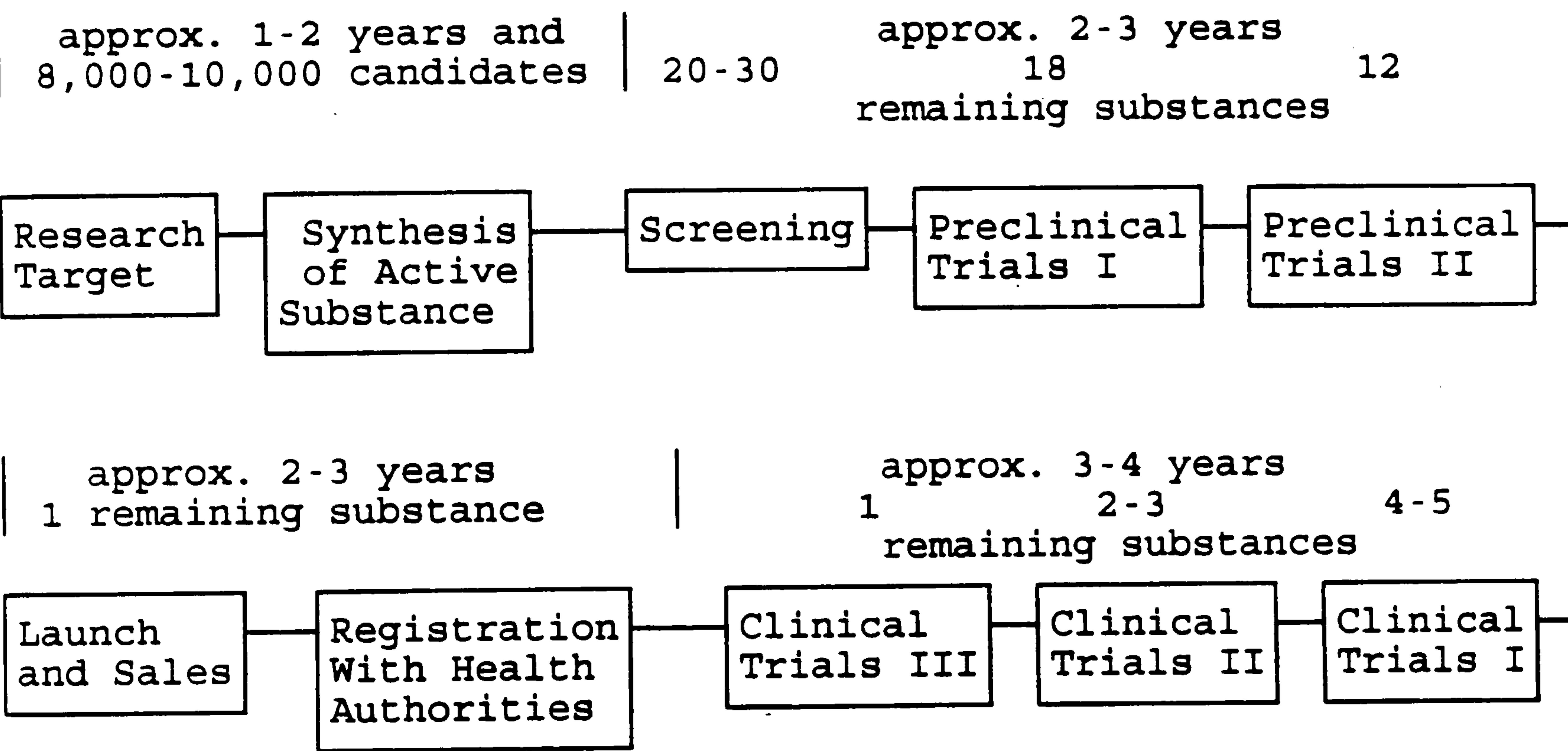
4.4.2 Pharmaceutical Innovation and Risk and Return in Pharmaceutical R&D

*"Pharmaceutical innovation refers to the testing of new chemical entities (NCEs) in man, which produce a therapeutic advance for the patients".
(Prentis & Walker, 1988; Eisman & Wardell, 1981).*

Drug innovation is a highly complex, multi-disciplinary affair, which involves basic research, pre-clinical trials, clinical trials, drug registration and marketing. The entire process from discovery research, clinical testing, regulatory work, to the launch of the new drug takes about ten to twelve years. In modern pharmaceutical companies, these interlinked key activities are all planned, co-ordinated and managed through multi-disciplinary development teams. Each firm has its own way of describing and naming the various activities in the

research and development process. However, the time-scale involved in the development of an active substance from its first preparation in the laboratory to its launch in any pharmaceutical firm can be described in Figure 4.2.

Figure 4.2 The Time-Scale of New Drug Research and Development



Source: D. Bartling and H. Hadamik (1982), "Development of a Drug"

The decision of a pharmaceutical company to evaluate a NCE in man for the first time represents a major commitment. It requires a considerable financial investment that has to be met from the income of products already marketed. Innovation and the financial returns from its success in the pharmaceutical industry are therefore closely related.

There have been frequent criticisms about the high return on equity enjoyed by pharmaceutical firms, which is believed to result from the high profitable pharmaceutical R&D. However, Joglekar and Paterson (1986) argue that those criticisms fail to consider other characteristics of the pharmaceutical industry, such as the riskiness of the investment in pharmaceutical R&D. Using a hypothetical example, Brozen (1977) made a convincing case why surviving and successful pharmaceutical firms will have a higher rate of return than surviving and successful firms in other industries.

Joglekar and Paterson's (1986) research assesses the profitability and risks of a 1976 decision to invest in NCE-related R&D. They conclude that on average, investment in pharmaceutical R&D for NCEs pays - at least more than does an investment in bonds. However, this is true only in the aggregate and over the long term. The odds of attaining the average NCE's return of 6.1% are less than one in five during a 15 year sales period.

Yet, this estimated IRR is large enough to explain current levels of investment in pharmaceutical R&D. Confident company executives with a successful track record may be justified in expecting to do better than average, and may also have adequate surplus from past success to continue such investment. A better than average return may also be achieved by targeting a firm's R&D at therapeutic classes affecting large segments of the population. On the other hand, for a new or small pharmaceutical firm, the situation could be problematic. Such a firm may not have the resources to introduce as many as three to six NCEs until one of them produces above average returns; and the firm may not be able to wait for 15 to 30 years for the payback of its investment.

For any pharmaceutical firm, apart from high technical risks involved in drug R&D, several other risk factors affect its return on R&D as well. They are (a)

foreign market, (b) government policy, and (c) generic replacement when NCE patents expire.

4.5 THE R&D/MARKETING INTERFACE IN THE PHARMACEUTICAL INDUSTRY

"There are obvious conceptual differences between R&D and marketing groups, the most apparent of which is the constant conflict between the long- and short-term demands for the firm's resources. Marketing wants bottom line performance and output today, while the goals of research are often focused on the future" (Faust, 1984, pp. 63).

According to Costjens (1991), the link between R&D and marketing is particularly difficult in the pharmaceutical industry for three fundamental reasons.

- (a) The still predominant trial and error nature of basic research.
- (b) Market testing involves ethical responsibility.
- (c) The relative dominance of R&D over marketing.

In the pharmaceutical industry marketing has been traditionally involved in two aspects of the research and development process. First, it is involved in defining the nature of the clinical studies in order to create a differential advantage for the new product. Second, it suggests directions for R&D efforts to defend existing products by broadening claims, discovering evidence for new indications and creating new dosage forms and formulations (Corstjens, 1991).

It is reported by a vice president of a large drug company that marketing people are very good at estimating market potential for therapeutic areas in which the market is reasonably well established. However, they are less able to deal with markets for which no effective therapy exists. The key problem seems to be in the area of providing market and marketing inputs for truly new product areas. The currently available new product forecasting approaches are predominantly developed for products in established markets (Corstjens, 1991).

Nevertheless, marketing techniques have become more and more formalized and sophisticated over the past decade. Medical Marketing & Media

(September, 1989) reported a "remarkable proliferation" of the marketing alternatives including single-sponsored publications, computer programs, telemarketing and teleconferences, seminars and symposia, prescription pads and patient files, poster services and references. Those alternatives may be used to achieve different goals. According to Mr. Robert J. Botto, President of Botto & Messinger Inc.,

"From a marketing standpoint, some are more strategic in nature, while others compete with traditional media for exposure. There is a difference between what you want to achieve with a symposium or seminar and what you want to achieve with advertising on a prescription pad or a patient file." (Medical Marketing & Media, September, 1989).

With the increased strategic importance of the marketing department in pharmaceutical firms, efforts have been made by top management, the R&D department and the marketing department towards a more effective R&D/marketing interface in drug innovation. Marketing people for example, try to solve the problem of frequently changing requirements in the market place by distinguishing essential requirements from would-be-nice requirements, and the research people will then try to meet those requirements according to their priorities (Glaxo sources).

4.6 THE U.K PHARMACEUTICAL INDUSTRY

The U.K. is the second most prominent nation after the U.S. in the discovery of successful drugs. The U.K. has gone from strength to strength over the period 1985 to 1990, increasing its best selling brands from nine to thirteen (see Table 4.1).

Table 4.1 Top 50 Branded Products Worldwide By Country Of Origin

Country	1985	1986	1987	1988	1989	1990
U.S.	23	23	23	19	18	19
U.K.	9	9	10	10	12	13
Germany	5	5	4	5	5	5
Japan	5	5	5	6	6	4
Switzerland	6	5	5	4	4	4
Sweden	1	1	1	1	1	2
France	1	1	1	2	2	1
Italy	0	1	1	2	2	1
Norway	0	0	0	1	1	1

Source: BZW Research. Medical Marketing & Media, Aug. 1991.

The number of best-sellers produced by a company may reflect its marketing proficiency, its R&D capability or a combination of the two. Ultimately, it reflects the competitiveness of companies (Pass, 1991). Table 1 shows that Merck and Glaxo's ability to translate research into revenues has been significantly greater than that of other companies. Of the sixteen companies that have originated or marketed more than one 1990 top-50 branded drugs, four are British companies. They are Glaxo, SmithKline Beecham, ICI, and Wellcome (see Table 4.2). The R&D/marketing interface in drug innovation within these four leading British companies will be studied in chapters 4-7.

Table 4.2 Companies that have originated or marketed more than one 1990 top-50 branded drugs

Company	No. of Top-50 Drugs Originated	No. of Top-50 Drugs Marketed
Merck	5	6
Glaxo	5	4
Bayer	3	2
SmithKline Beecham	3	3
Eli Lilly	2	3
ICI	2	2
Yamanouchi	2	1
Bristol-Meyers Squibb	2	2
Hoechst	2	2
Sandoz	2	2
Sankyo	1	1
Wellcome	2	2
Astra	2	1
Marion Merrell Dow	1	2
Pfizer	1	2
Ciba-Geigy	1	3

Source: BZW Research, Medical Marketing & Media, August 1991.

Britain's reputation as a world leader in the pharmaceuticals industry has been confirmed in a recent investigation by The Sunday Times. Six of the twenty best-selling drugs in the world are now British-made and four of the world's twenty biggest pharmaceutical companies are British. (see Tables 4.3 and 4.4).

Table 4.3 1990 World's Best-Selling Drugs

Drug	Purpose	Maker	Sales, fm
1 Zantac	Peptic ulcer	Glaxo	1,600
2 Adalat-Procardia	Angina	Bayer-Pfizer	950
3 Rentec	Hypertension	Merck	870
4 Capoten	Hypertension	Bristol-Meyers Squibb	850
5 Kefral-Ceclor	Antibiotic	Lilly-Schinogi	650
6 Tenormin	Hypertension	ICI	640
7 Tagamet	Peptic ulcer	SmithKline Beecham	630
8 Voltaren	Arthritis	Ciba-Geigy	630
9 Cardizern-Herbesser	Angina	Marion	590
10 Ventolin	Asthma	Glaxo	510
11 Naprosyn	Arthritis	Syntex	460
12 Gaster-Pepcid	Peptic ulcer	Yamanouchi	440
13 Mevacor	Cholesterol	Merck	430
14 Augmentin	Anti-biotic	SmithKline beecham	410
15 Isoptin-Calan	Angina	BASF	410
16 Rocephin	Antibiotic	Roche	400
17 Prozac	Antidepressant	Lilly	400
18 Zovirax	Antiviral	Wellcome	380
19 Feldene	Arthritis	Pfizer	370
20 Ciprobay	Antibacterial	Bayer	360

Source: The Sunday Times, 5 January 1992.

Table 4.4 Top Drug Companies in 1991

Company	Nationality	Sales fbn	Market Share %
1 Merck	American	3.5	4.2
2 Glaxo	British	3.0	3.6
3 Bristol-Meyers Squibb	American	2.9	3.4
4 Ciba-Geigy	Swiss	2.3	2.8
5 SmithKline Beecham	British	2.3	2.7
5 Hoechst	Germany	2.3	2.7
7 Lilly	American	2.0	2.4
8 American Home Products	American	2.0	2.3
8 Roche	Swiss	2.0	2.3
10 Johnson & Johnson	American	1.9	2.3
11 Pfizer	American	1.8	2.2
12 Bayer	American	1.8	2.1
12 Sandoz	Swiss	1.8	2.1
14 Rhone-Poulenc	French	1.7	2.1
15 Upjohn	American	1.4	1.6
16 B Ingelheim	Germany	1.3	1.6
16 Marion-M Dow	American	1.3	1.6
18 Schering-Plough	American	1.3	1.5
18 ICI	British	1.3	1.5
20 Wellcome	British	1.2	1.3

Source: Sunday Times, 5 January 1992.

The Pharmaceutical industry has emerged as one of the few industries in which Britain is a genuine leader. Pharmaceuticals produced a trade surplus of £1.1 billion in 1990 and this climbed to £1.2 billion in 1991 (abpi estimation). Glaxo is now Britain's biggest company in terms of market capitalization, bigger even than BT. Glaxo is now valued at £25.6 billion while BT trails at £20.5 billion. In the past twenty-five years, the UK pharmaceutical industry has outperformed the London stock market by over 400%. The real boom years were the 1980s, which saw the value of the health and household sector increase tenfold, against a mere doubling for the stock market as a whole.

The success of British companies overseas, particularly in America, has ensured their place in the world drugs league despite the modest size of their domestic market. Glaxo, for example, earns more than 50% of its profits in America.

Analysts agree on several reasons why the pharmaceutical industry has succeeded where other British have failed. They include

- (a) a strong scientific tradition, which provides a ready supply of high-quality researchers;
- (b) a system of fixing prices with government, which guarantees returns on investment; and
- (c) strong management, which has effectively exploited these advantages.

Having achieved an outstanding performance in 1980s, the UK pharmaceutical industry is now facing a big question - can the British drug companies keep it up, can their stunning performance continue in the 1990s, with so many companies in competition? The key is the continuing development of innovative products.

The four leading UK pharmaceutical firms, Glaxo, SmithKline Beecham, ICI Pharmaceuticals and Wellcome are studied in the current research. The case studies of a total of twelve drug innovations are carried out starting from the next chapter. The dynamic pattern of these drug innovations over a period of

time can be used as a case history. It illustrates the ways in which research people and commercial people of the companies have cooperated in coming up with innovative drugs that are critical for firms' long term growth.

INTRODUCTION TO THE CASE STUDIES

The study described in this thesis is based upon four pharmaceutical companies and three drug innovation cases within each company. These companies are Glaxo, SmithKline Beecham, ICI Pharmaceuticals and Wellcome plc, and these drugs are Zantac (anti-ulcer), Imigran (anti-migraine), Serevent (anti-asthmatic), Tagamet (anti-ulcer), Augmentin (antibiotic), Eminase (cardiovascular), Tenormin (cardiovascular), Diprivan (anaesthetic), Zoladex (anti-cancer), Zovirax (antiviral), Retrovir (antiviral) and Lamictal (anti-epileptic). The criteria for choosing the four companies and the total of twelve drugs have been described in Chapter 2, "The Research Methodology". The within-case analyses are presented in Chapters 5 - 8 respectively. Each chapter involves detailed case study write-ups of three drug innovation projects from one company. Apparently, the emphasis of the present work is on the cross-case analysis in Chapter 9, where the richest information has been processed through the previous within-case analyses. Nonetheless, the within-case analyses themselves are critical in providing a mechanism for coping with the large data volume. In addition, this process enables us to become intimately familiar with each case as a stand-alone entity and allows the unique patterns of each case to emerge before generalising across cases.

In the within-case analysis, a general analytical strategy was applied which relies on the theoretical propositions presented in Chapter 3, the theoretical framework. This provides the case study analysis with a theoretical orientation. The within-case analysis is in fact organized under the three constructs which have been defined in Chapter 3: the environmental constructs, the strategic constructs and the organizational constructs. When assessing these constructs at the end of each drug innovation case study, no special assessment methods are used for the organizational and the strategic constructs. Instead, the original qualitative information regarding these two groups of constructs are merely summarized by using several tables. However, the assessment of the environmental constructs is more complicated since several facets are included in each construct. In order to compare the environmental constructs across different cases, checklist models are adopted. The reasons for adopting this model have been provided in Chapter 2, "The Research Methodology"

In each of the within-case analysis chapter, a preliminary discussion is provided following each drug case study, and a final analysis is presented at the end of the chapter. However, it should be noted that due to the nature of the information provided at this stage, only tentative suggestions are given. These suggestions will be reviewed and compared as more information is presented and analysed later in the cross-case analysis in Chapter 9.

CHAPTER 5 THE GLAXO CASE

5.1 INTRODUCTION

Glaxo was formed in Wellington, New Zealand in 1873 by Joseph Nathan, a British emigrant. The trade name Glaxo was registered in 1906 for the company's product - infant's milk. In the 1950s, after absorbing Allen & Hanburys, Glaxo made the central decision to become a science-based pharmaceutical concern. The major activities became the development of antibiotics, steroids and respiratory medicines, all of which sold mainly in Britain. In the late 1960s, the group moved into fundamental research. In the following two decades a number of important drugs were discovered (see Table 5.1).

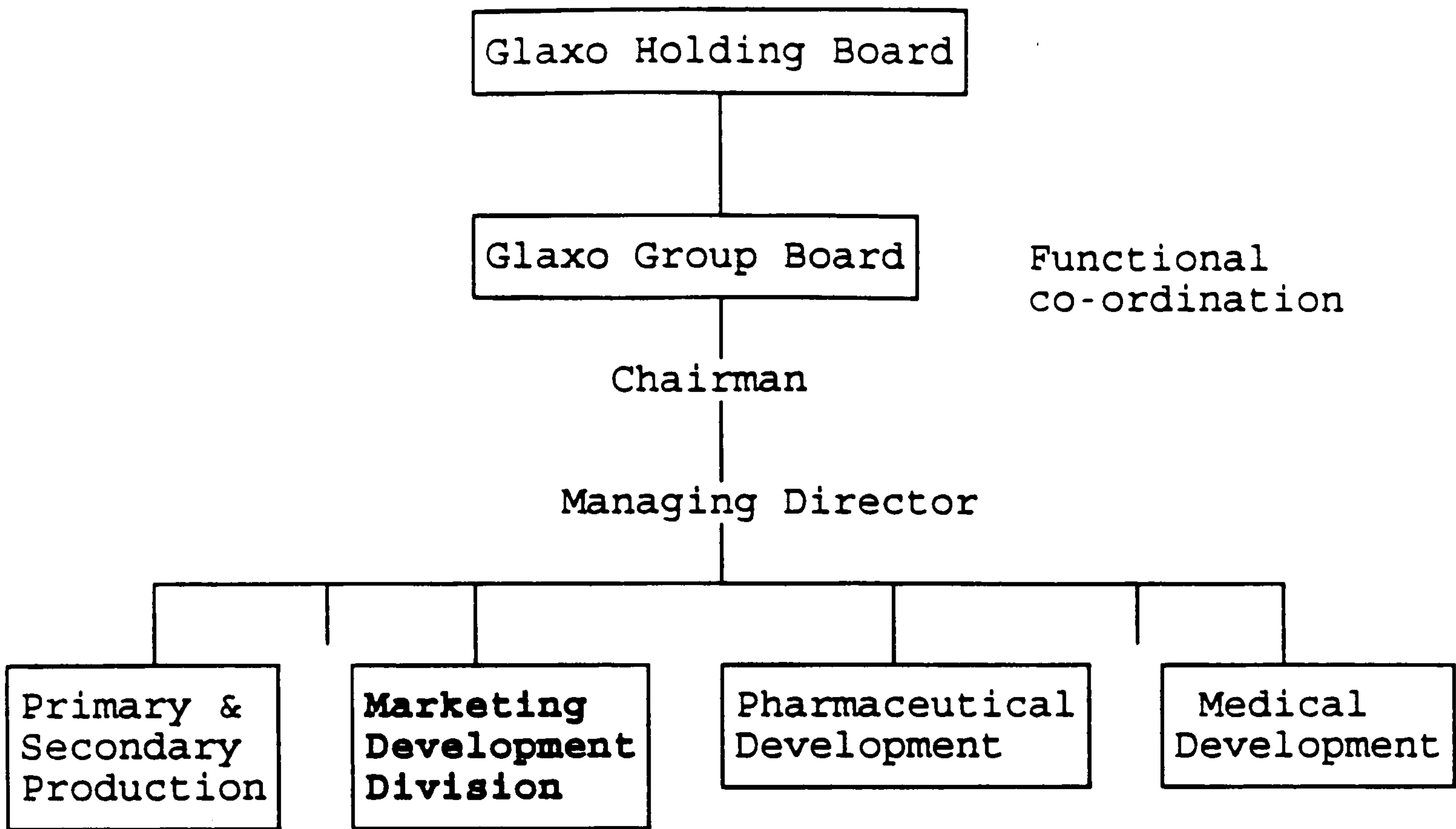
Table 5.1 Principal Glaxo Discoveries 1964-1990

Brand name	Generic name	Type	First launch
Ceporin	Cephaloridine	Injectable antibiotic	1964
Vintolin	Salbutamol	Anti-asthmatic	1969
Becotide	Beclomethasone	Anti-asthmatic	1972
Beconase	Beclomethasone	Anti-rhinitic	1975
Trandate	Labetalol	Anti-hypertensive	1977
Zinacef	Cefuroxime	Injectable antibiotic	1978
Zantac	Ranitidine	Anti-ulcerant	1981
Fortum	Ceftazidime	Injectable antibiotic	1983

Source: March 1987, Accountancy.

Since 1980, the company has decided to concentrate on ethical pharmaceuticals, and its R&D structure has been internationalised. The organizational structure of Glaxo has reflected this corporate strategy (see Figure 5.1).

Figure 5.1 Glaxo Business Structure



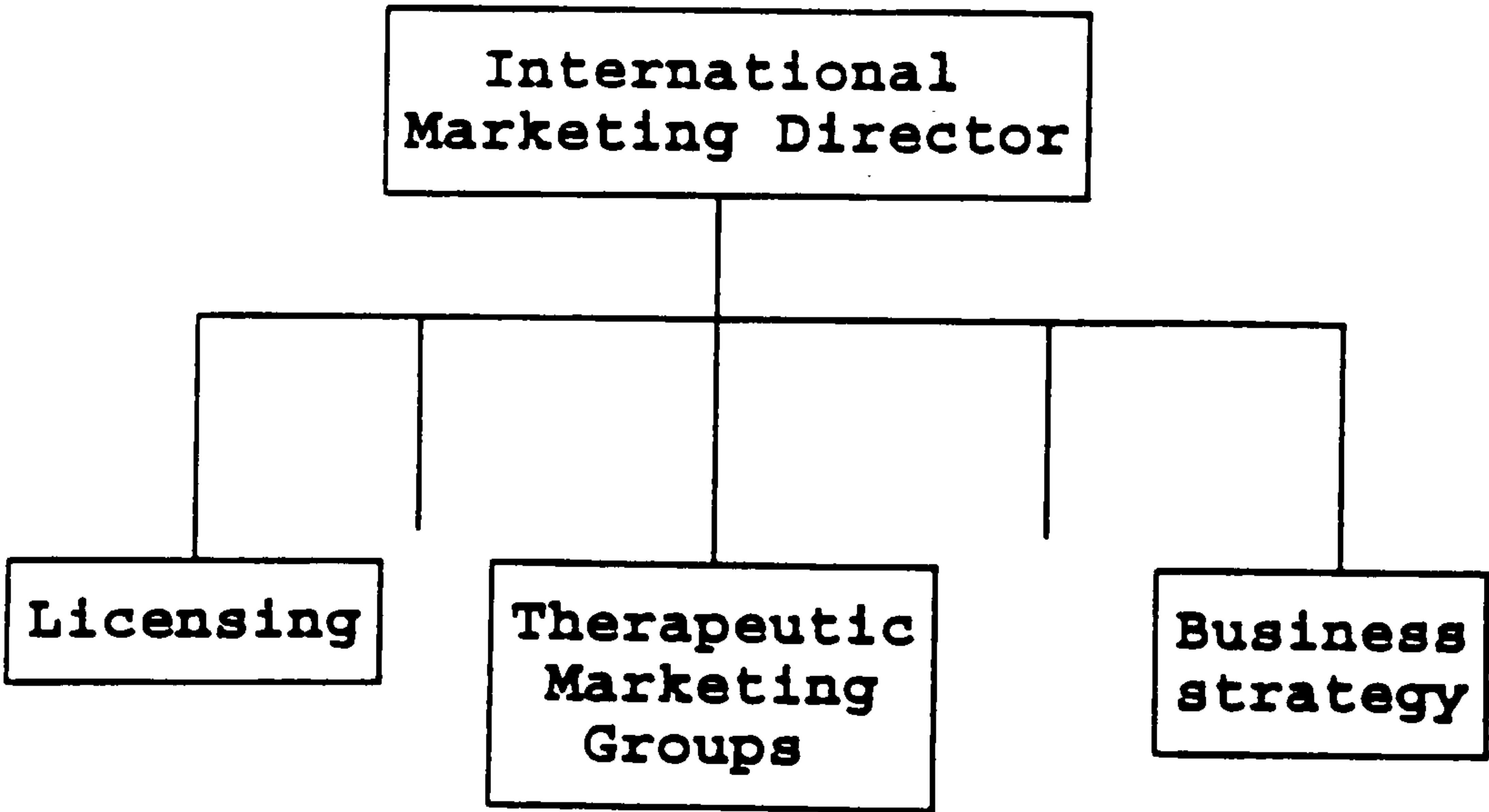
Major research facilities have been opened in many countries such as the United States, Japan and Italy. The company's R&D activities are carried out within Glaxo Group Research Limited (GGR). They are managed through the five therapeutic groups, namely anti-ulcer, respiratory, antibiotic, cardiovascular and dermatological. Table 5.2 summarises the resources devoted to R&D activities in drug innovation process in Glaxo.

Table 5.2 R&D Activities, Manpower and Spending in Different Stages of R&D Process

Stages	Discovery Research	Exploratory & Full Development	Marketed Product Development
Acti- vities	Scientists from varies disciplines endeavour to discover new chemical entities.	Pre-clinical and clinical trials with healthy volunteers and patients to test the safety and efficacy of the NCE; data collection for drug registration purposes.	Development and management of the existing products through line extension, new formulation, and indications.
No. of people	1800	2820	800
% of spending	30	40	30

Glaxo's marketing activity has been carried out by one international marketing organization and a large number of local marketing groups. As well as coordinating Glaxo's local groups throughout the world, the international marketing organization cooperates closely with R&D within each therapeutic groups (see Figure 5.2).

Figure 5.2 The Structure of Marketing Development Division



Having sustained the fastest growth rate among the world's pharmaceutical companies for ten years (see Table 5.3), Glaxo has become the world's second largest pharmaceutical company. Its R&D productivity is also the highest of such companies (see Appendix 6).

Table 5.3 Statistical Review of Glaxo Holding plc

Years to 30th June	1990 (£m)	1980 (£m)
Turnover	2,854	434
Profit before taxation	1,140	66
R&D expenditure	399	32
Number of Group employees	31,327	29,187
Glaxo sources		

The anti-ulcer drug, Zantac, developed by Glaxo and launched in 1981, has been critical to the company's success over the last decade. Zantac remains by far the world's best-selling prescription medicine. Sales of Zantac account for 50% of Glaxo's total sales. However, as demand for Zantac has already peaked, new products are needed. Glaxo has committed a five-year R&D budget of 2.5 billion pounds for new drug development. Glaxo's announced goal is to have one major new drug and three or four line extensions approved each year.

In this chapter, three products which have been developed during the past twenty years - Zantac, Serevent and Imigran - are studied. Table 5.4 and Table 5.5 are the time scales and descriptions of these three products.

Table 5.4 Product Development Time Scales

Drug									
Serevent	Development			Launch		Post market			
	1984			1990		(PED: 2009)			
Imigran	Development			Launch		Post market			
	1984			1991		(PED: 2010)			
Zantac	Development		Launch		Post market				
	1976		1981		(PED: 2002)				
----- Year									
	65	70	75	80	85	90	95	2000	

Table 5.5 Product Descriptions

Drug	Description	Innovation Level
Zantac (ranitidine)	a anti-ulcer drug launched in 1981, remains by far the world's best-selling drug. its Sales account for about half of Glaxo's total sales.	Moderate/High Second entrant into new class
Imigran (sumatriptan)	A novel 5HT1A agonist for the treatment of migraine. it has a novel mode of action, launched in 1991.	Very High. New class of drug.
Serevent (salmeterol)	a asthmatic treatment, an improved bronchodilator and possibly an anti-inflammatory agent, launched in the UK in Dec. 1990.	High. Novel agent in established class.

5.2 THE R&D/MARKETING INTERFACE IN DEVELOPING ZANTAC

5.2.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

The size of the world's market for peptic ulcer treatment was estimated at £1 billion a year in 1981 - the year when Zantac was introduced. The market was relatively new, yet growing. However, Zantac was not the first product in its class - the so called H2 antagonist. Doctors had gained some experience since the successful launch of SmithKline's Tagamet - the first H2 antagonist - five years previously.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

The fierce competitive situation of Zantac was highlighted by the existence of a dominant competitive drug - Tagamet, marketed by SmithKline, a multinational pharmaceutical giant.

However, although Tagamet represented a significant therapeutic advance, it showed certain side effects and poor interaction with other drugs. Hence, the need for a better drug was perceptible. The competitive opportunity for Glaxo depended largely on the degree to which the current customers were satisfied by Tagamet and the degree to which Glaxo was able to convince the customers about the superiority of Zantac to Tagamet in meeting customer needs. In 1986, Glaxo succeeded in overtaking SmithKline when Zantac became the world best-selling drug. This position has been maintained to the present day. However, Zantac is facing possible generic competition when its patent expires in 1995.

(2) Technological Uncertainty

(i) Cause of Disease (CD)

Precisely what causes peptic ulcer is still wrapped in mystery. It is however found that peptic ulcers occur only in the presence of gastric acid in the stomach. Before Zantac, SmithKline had discovered that histamine, a chemical substance which was known to be involved in the acid secretion in stomach, has two receptors, only the second of which, the H₂-receptor, is responsible for acid secretion.

(ii) Mode of Action (MA)

Zantac was the second H₂-antagonist after SmithKline's Tagamet. Both drugs block off the action of H₂ receptors. However, Glaxo's scientists were able to modify the structure of the drug in such a way that the new compound shown longer duration of action and selectivity of action¹.

(iii) Side Effect (SE)

A major advantage of Zantac over its rivals is its safety profile. The drug has very low side effect and is safe to be taken with most other drugs.

(3) Internal Marketing Expertise and Technological Strength

(i) Marketing Experience (ME) and Company Reputation (CR)

Glaxo was not a well-known company in the world anti-ulcer market. The company's major markets were antibiotic and anti-asthmatic in the U.K. (see Table 1). However, the corporate management was determined to expand internationally prior to Zantac's development. Following this aim, in the 1970s,

the company established a marketing force in the U.S., which later provided a important base for Zantac launch.

(ii) Research Experience (RE) and Development Experience (DE)

Glaxo had no development experience in anti-ulcer drugs before Zantac. Nevertheless, the research team had substantial past experience in related areas.

5.2.2 Strategic Constructs

(1) The Corporate Strategic Dimension of the Interface (CSD)

Glaxo's corporate management was not involved in the Zantac project before the exploratory development stage. After the drug's potency was realised, it was given the highest priority through the full development stage, i.e. fast-tracked. Since then, most of the strategic decisions such as the organization of clinical trials and price policy was made at the corporate level with both R&D and marketing directors involved. Dr Richards, Medical Director of Glaxo Group Research recalled,

"We decided to carry out clinical trials on an international scale for the first time. This decision was conditioned by marketing as well as clinical considerations. In the past, we had not been very good at generating clinical information as a spring board for the marketing department. The cooperation between us were essential for the successful implementation of this decision" (Glaxo Sources).

In addition to the cross-functional cooperation, top management's determination and risk-taking style had a significant impact upon the drug's success. A press comment noted that:

Glaxo had the nerve to launch Zantac into the US market at a 40 per cent premium to its established competitor, SmithKline's Tagamet, betting on market acceptance, and it won" (14 July 1991, The Independent).

(2) The Corporate Technical Dimension of the Interface (CTD)

The evaluation of external technological trends and internal technological competence was mainly carried out by the R&D department. A search for an

anti-ulcer compound in Glaxo R&D was already initiated before SmithKline's discovery of Tagamet. After the discovery was published, Glaxo's research team adapted quickly to this emerging opportunities. Having monitored closely the progress of Tagamet development by attending seminars and meetings regarding the drug, the research team switched its goal to finding an improved H2-antagonist, instead of a completely new agent.

(3) The Operational Dimension (OD)

Marketing research was carried out mainly for strategic purposes, including the investigation into the level of customer satisfaction with Tagamet and the preparation for promotional materials. According to Mr Railton, marketing manager for Zantac,

"We had no big difficulty in obtaining market data we wanted because the market was not completely new, Tagamet had been in the market for sometime". (24th June, 1991, telephone interview).

(4) The Product Strategic Dimension (PSD)

Despite the fact that most of the strategic decisions were made at the corporate level, the interface at the project level contributed to the transfer of the drug's technical advantage into the competitive advantage in the market place. A marketing effort was made to convince ulcer patients of the importance of such technical advantages as lower side effect and less dosage in their treatment, especially in preventing future attacks. The idea was that because Zantac was safe and convenient, a maintenance dose should be taken regularly to avoid another attack. Through this strategy, the company expanded its market share in the anti-ulcer market substantially. It was noted that:

"The sales force touted Zantac's advantages as a drug that could be taken half as frequently as Tagamet without the side effects. Beginning in 1983, the company blitzed hospitals, clinics, and most important, the family physicians who were Tagamet's biggest fans, with a whirlwind of seminars and advertising." (Fortune, Nov.6, 1989).

(4) The Product Technical Dimension (PTD)

The interface in this dimension contributed to the development of the twice daily dosage of Zantac, which proved to be critical for the product success. However, because the priority of the project was speed, product feature decisions such as the colour of the drug were oriented to time-saving, rather than marketing. As Dr Padfield, the former Pharmacy Director, explained,

"We wanted to avoid any registration problems as a result of the colour we chose. We went for white to play safe. It was a purely pragmatic decision to get us to market as soon as possible" (Glaxo sources).

5.2.3 Organizational Constructs

(1) The Interface Coordination Mechanism (ICM)

The coordination mechanism of Glaxo was relatively poor before the Zantac project. Zantac catalysed changes within the company. According to Mr Taylor, the former Group Chief Executive,

"We were capable of creating excellent drugs, but were patchy at turning research ideas into successful products. Zantac, therefore, would not have been so successful without changes taking place within the organization prior to its launch" (Glaxo sources).

The Zantac programme required each centre of activity to discover and anticipate the needs of the others. It drew out new skills and mechanisms in coordinating between the company's geographic parts and its functional parts. Zantac was developed and brought to market through a worldwide and simultaneous coordination mechanism, rather than locally and sequentially as had always been the case in the past. At the top level the R&D/marketing interface was mainly coordinated through Committees, and at the product level a cross-functional project team was formed.

(2) The Interface Communication Flows (ICF) and Interface Conflict (IC)

The communication between R&D and marketing in Zantac development was effective. Dr Padfield acknowledged the importance of liaison in Zantac success,

"We had frequent contact with clinical development people, marketing people and so on, which was important. For example, we had to talk constantly with the marketing people to discover what they wanted in terms of presentation, dosage forms and likely shelf lives" (Glaxo sources).

According to Dr Towler, the Group Director of Development Planning,

"We maintained good communication from very senior level to very low level by means of video conferences, project meetings, and so on. In fact, one of the important factors for Glaxo's success is communication" (face-to-face interview, 6th March, 1991).

However, dis-appreciation of each other's contribution to Zantac success was observed between these two departments. Dr Hoston, the research manager, for example, commented that:

"Zantac has succeeded because it is a good product itself, marketing for Zantac was not good, and the promotional materials were poorly produced" (telephone interview, 7th March, 1991).

Chris Piggin, the Clinical Trials Planner recalled that:

"Our impression about marketing is that they tend to change their mind more often in terms of the product features. They have relatively short time horizon, which was mainly concerned with the present market. This sometimes caused problems for us, in terms of the organization of the clinical trials" (telephone interview, 17th July, 1991).

Conversely, marketing people believed that they have made significant contribution to the drug's success in the market. According to Mr White, a former product manager of Glaxo (who has now left the company),

"The twice daily dosage and less side effects of Zantac would not mean much to the anti-ulcer market because peptic ulcer is not a condition for which patient needs to have treatment regularly. He would only take the drug when he needed. Glaxo's marketing was extremely clever in convincing the customers and in expanding the market" (telephone interview, 3rd August, 1991).

(3) Relative Influence of R&D and Marketing (RIRM)

The project was initiated by the research. At the early research and exploratory development stages, the research team had a dominant influence on the project. However, after the drug's potency was discovered, the project became a corporate concern. The main goal was to find an improved anti-ulcer drug to compete with Tagamet. The project was therefore strongly competition oriented and the corporate management provided the major driving force.

Nevertheless, there was still some degree of power shifting between the R&D and marketing departments at the full development stage. For instance, in the coordination of worldwide clinical trials, the emphasis was on the scope and the speed, thus a close cooperation rather than one party dominance was called out. On the other hand, although the interface was also close in the pre-launch stage, since the objective was to transfer the drug's technical advantage into a competitive advantage in the market, the marketing department played a leading role.

5.2.4 The Innovation Performance

On the basis of the theoretical framework, the innovation performance was evaluated by measuring the Development Speed of the drug innovation (DS), the Innovative Level of the new drug (IL) and the absolute and/or the percentage of the new drug Sales.

(1) Development Speed (DS)

The development speed of Zantac was extremely fast. The whole process from the first synthesis to the market launch of Zantac only took five years and four months, compared with the industry average of eight years. This fast development speed indicates that the company has saved the critical time resources needed to develop a marketable product. It also proved the company's ability in fast-tracking strategically important drug innovations.

The motive for speed was competition. The key to this speed was world-wide simultaneity and telescoping successive phases. Dr Brittain, the then research director recalls that:

"In the development process, success was assumed and plans were drawn up. Tests were undertaken almost simultaneously rather than sequentially. Had we done our tests strictly one after the other we could have lost a year or more in development time"
(Glaxo Sources).

(2) Innovative Level (IL)

Zantac was the second entrant to a new class. Its innovation level was scored moderate/high. However, although not highly innovative, the drug was perceived by the customers as being superior to competing products in meeting their needs.

(3) Sales Revenue (SR)

Zantac achieved a high sales revenue. Launched in 1981, by 1986 it captured half of the £2.1 billion peptic ulcer market. In 1990, it generated £1,600 million sales, which was nearly half of the company's total sales and more than twice of the sales of Tagamet.

5.2.5 Summary

Qualitative measures are used for the environmental, Strategic, and organisational constructs. In particular, the environmental constructs are measured using the checklists method described in Chapter 3, the theoretical framework. The assessment of all the constructs is presented in Tables 5.6 to 5.9. Following the assessment, a preliminary discussion of the case will be presented. The results of this chapter will then be analysed and compared with other drug innovation cases in the cross-case analysis presented in Chapter 9.

(1) Assessment

Table 5.6 Assessment of the Environmental Constructs in the Zantac Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	1	1	2	4	1	1	0	2	1	0	1	0	2

Table 5.7 Assessment of the Strategic Constructs in the R&D/Marketing Interface in the Zantac Project

CSD	PSD	OD	PTD
was present and effective, and top management commitment was most critical.	was highly effective in utilizing technical merits for competitive purpose.	was highly effective in collecting appropriate market information.	was effective in deciding dosage and formulation.

Table 5.8 Assessment of the Organizational Constructs in the Zantac Project

ICM	ICF	IC	RIRM
Product Development Committee Corporate level and Cross-functional team at lower level.	Frequent and effective.	Lack of appreciations of each other's work.	Research driven at early stage; a closer link at clinical trials stage; and marketing played a key role at pre-launch stage.

Table 5.9 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, fbn	
				5th yr	15th yr
5.4	very fast	moderate/high second entrant in a new class	superior in meeting customer needs	1	1.6

(2) Preliminary Discussion

Zantac was not first to the market, however the company had never launched an anti-ulcer drug before and the technology used to develop it was also new to the firm. Therefore the Zantac project was an "unrelated-technology and new-

market" type of project. The market and technological conditions for the Zantac project are shown in Table 5.6. While the market uncertainty for the project was relatively high, scoring 4 out of 8, the technological uncertainty was low, and was only scored at 2 out of 6. Moreover, the company's internal technological and marketing expertise were not strong in Zantac project (2 out of 8).

The R&D/marketing interface was present in all dimensions except for the CTD, where the firm's R&D department, especially the research team, played a leading role. The interface was relatively close in some of the dimensions such as the PSD and OD. Moreover, the R&D/marketing interface was well coordinated at both corporate level and project level. The cross-functional communication was frequent and effective, which was largely attributable to top management's commitment to the project. The performance of the drug development was outstanding, both in terms of the development speed and the sales.

This case tends to suggest that the relatively high marketing uncertainty (which mainly resulted from competition rather than new market situation) and the lack of internal expertise may be compensated by the presence of a strong R&D/marketing interface in all dimensions. This would confirm the important role of the R&D/marketing interface in product innovation.

In addition, the case evidence tentatively suggests that an effective R&D/marketing interface depends on effective communication, and that the commitment of top management to the project is conducive to effective communication. Meanwhile, the power shifting between the R&D and marketing departments during the drug development process seems to be associated with changing external and internal environment. In particular, the department that possesses the most appropriate skills and the information (i.e. internal strength) to cope with critical uncertainty (i.e. technological and/or market uncertainty) comes to have stronger influence.

On the other hand, the lack of appreciation between R&D and marketing does not seem to have a significant effect upon the effectiveness of the interface. This implies that the state of lack of appreciation at the interface may be categorised as mild disharmony.

5.3. R&D/MARKETING INTERFACE IN DEVELOPING IMIGRAN

5.3.1 Environmental Constructs

(1) Market Uncertainty

a. Market Size (MS) and Market Newness (MN)

Glaxo's Marketing research showed that there were 35 million migraine sufferers world-wide. However, there was no adequate therapy for migraine patients before Imigran.

b. Customer Need Awareness (CNA) and Market Competitiveness (MC)

Customer need awareness was relatively low in the migraine market. Instead of calling a doctor, most sufferers just took aspirin and went to bed.

Imigran was the first entrant to a new market, in which as indicated above, there was no direct competition. The major objective of the company was to stimulate primary demand in the market.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of migraine was little known. The Imigran research programme was based on the assumption that migraine is caused by the dilation of blood vessels in the brain.

By applying a tissue-oriented research approach, the Glaxo team discovered a family of receptors which was believed to be involved in migraine. The Imigran project involved high technological uncertainty. A press comment noted that:

"Glaxo is now taking major risks. Taking its promising new anti-migraine drug, though some analysts think the drug could become a \$1 billion seller, nobody knows for certain. It is possible that the attacks are caused not by the dilation of blood vessels, but by the erroneous activation of pain pathways in the nervous system. If so, then sumatriptan may not turn out to be the breakthrough that Glaxo clearly believes it is" (The Economist, Nov. 17, 1990).

(ii) Side Effect (SE)

Imigran had some adverse effects. It could cause symptoms associated with heart disease. Therefore patients with a heart condition were advised to use Imigran only under medical supervision.

(3) Internal Technological and Marketing Strength

(i) Marketing Expertise (ME) and Company Reputation (CR)

Imigran was the company's first product in the cardiovascular market. However, attempts were made from the early stages of the development to make the drug known to the market. In addition, although not specifically related to the cardiovascular market, the company had a good reputation as a successful innovator.

(ii) Research Experience (RE) and Development Experience (DE)

As noted earlier, the Glaxo research team applied the tissue-oriented research approach in the Imigran programme. This approach had been applied in many other drug innovation projects in the past twenty years, including Ventolin, an anti-asthmatic treatment, and Zofran, an anti-emetic in cancer therapy. On the other hand, the development activities of anti-migraine drugs such as the clinical trials organisation and the drug registration were a new experience to the company.

5.3.2 Strategic Constructs

(1) Corporate Strategic Dimension of the Interface (CSD)

The need to develop an anti-migraine drug was realized at the corporate level two years before Imigran was first discovered in the research laboratory. According to Mr Satterthwaite, the Marketing Manager for Imigran,

"The company had recognised that a strong presence in the cardiovascular market was strategically important. However, because migraine is such a poorly understood disease, long-term fundamental research was needed before this goal could become realistic" (telephone interview, 24th June, 1991).

The drug was given high priority by the company at full development stage. Since then the interface between R&D and marketing was close in the identification of potential customers and the coordination of simultaneous worldwide approval.

(2) Corporate Technical Dimension of the Interface (CTD)

Imigran research and development involved the discovery of new scientific knowledge beyond the company's existing technologies. The balance between the commercial attractiveness and the risk of such a move toward a unfamiliar area was carefully assessed at the corporate level, where both R&D and marketing inputs were received. Dr Towler explained,

"In science-driven projects such as the Imigran project, both marketing and R&D were finding their way forward. A lot of new research needed to be done, and there are some unexpected distractions. However, this type of projects was necessary for the company's long-term growth, especially for a research-based firm like us. Of course, decisions concerning this type of project need to be very carefully evaluated at the top level, and that was what we did in Imigran project" (face-to-face interview, 4th July, 1991).

(3) Operational Dimension of the Interface

Marketing research was carried out to identify the drug's potential market. However, because the anti-migraine market was new and consumers attitudes towards medication varied considerably, the company's marketing department encountered great difficulties in collecting the required information. According to Mr. Satterthwaite,

"When a market is new, we need to look beyond the current market. Take Imigran as a example, we did extensive market research. We segmented the market into different groups according to the attitude of the patients towards medication and so on. We decided that this is a very potential market." (telephone interview, 24th June, 1991)

(4) Product Strategic Dimension of the Interface (PSD)

In this dimension R&D and marketing cooperated in establishing the customer link and in implementing the customer education programme. According to Mr Owen, Director of Business Strategy,

"The marketing people were responsible for communicating the product information to the market. They kept the customers informed of the development progress so that the customers would be ready to use the drug as soon as it was launched" (face-to-face interview, 23rd May, 1991).

Meanwhile, the education programme emphasised the significant benefit that Imigran could offer to the patients. Marketing and R&D interacted with each other making sure that the right data were generated from the clinical trials, and were carefully used in developing promotional materials.

(5) Product Technical Dimension of the Interface

There was no close R&D/marketing interface in this dimension, and most of the decisions was made on the basis of R&D considerations.

5.3.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

The cross-functional coordination mechanism operated in the Imigran project had been established and further developed since the company's anti-ulcer drug, Zantac, was brought to market in the 1980s. For instance, at the corporate level, there are Research Management Committees (RMC) to maintain a high level of co-ordination between the five therapeutic research areas in which Glaxo is involved. The meetings are research-driven. On the other hand, there are Product Development Committees (PDC) where commercial balance is maintained through the presence of Commercial Director, Marketing Director and Research Director. At the project level, the R&D/marketing interface is coordinated through project teams.

(2) Interface Communication Flows (ICF) and Interface Conflict (IC)

Despite the fact that the communication between R&D and marketing in Imigran development was relatively effective, conflict occurred during the development process. Mr Satterthwaite recalled:

"Imigran was a science-driven project, and our close cooperation began fairly late. Also we had a few problems. The research people were not always happy with what we provided for them. But they did not seem to understand that in a new market, many things had to start from scratch, not just the research but the marketing as well" (telephone interview, 24th June, 1991)

(4) Relative Influence of R&D and Marketing (RIRM)

Imigran was initiated by the research department, and remained research-driven during the development programme. The R&D department had a relatively strong influence on the project until the pre-launch stage when the customer education programme was launched. At this stage, marketing started to exert a stronger influence.

5.3.4 The Innovation Performance

(1) Development Speed (DS)

The Imigran development programme took six and half years, which is shorter than the industry average of eight years. Although there was a strong motive for speed, the goal for a world-wide simultaneous approval was not realized.

(2) Innovative level (IL)

Imigran was the first entrant to a new class. The innovative level was very high.

(3) Sales

The sales of Imigran were high. Only one year after its launch, in 1992, it generated £400 million in sales, which was approximately twelve per cent of the company's total sales.

5.3.5 Summary

Using the same measures as indicated in Section 5.2, the assessment of the environmental, strategic and organisational constructs is presented in Tables 5.10 to 5.13. Finally a preliminary discussion is provided in this Section.

(1) Assessment

Table 5.10 Assessment of the Environmental Constructs in the Imigran Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	2	2	0	4	2	2	1	5	0	1	1	0	2

Table 5.11 Assessment of the Strategic Constructs in the R&D/marketing interface in the Imigran Project

CSD	CTD	PSD	OD
early, its effectiveness was increased at full development stage.	effective in assessing the new product opportunity.	highly effective in customer education and communication.	was present, but not very effective.

Table 5.12 Assessment of the Organizational Constructs in Imigran Project

ICM	ICF	IC	RIRM
Research Committee and Development Committee, project team at a lower level.	Relatively effective	Lack of credibility of marketing information and lack of mutual understanding.	Research remained dominant until full development and marketing started to exert strong influence.

Table 5.13 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, fbn the 1st yr
6.5	relatively fast	very high, new class of drug	unique and effective	0.4

(2) Preliminary Discussion

Imigran was the first effective pharmaceutical treatment for migraine patients and it involved the discovery of new scientific knowledge. Thus it belonged to the "new-market and new-technology" type of project. The environmental conditions for the Imigran project are shown in Table 5.10. While the market uncertainty for the project was moderate (4 out of 8), the technological uncertainty was very high (5 out of 6). Moreover, the company's internal technological and marketing expertise were not strong in Imigran project (2 out of 8).

The R&D/marketing interface was present in all dimensions except for the PTD, where most of the decisions was made on the basis of the R&D considerations. There existed an R&D dominance at the early stage of the innovation process. However, the interface became closer at the later stage of the innovation process, especially in the CSD and PSD. The communication was frequent, and the innovation performance was satisfactory.

This case tentatively suggests that, when a drug innovation involves new market and new technology, the interface in the CTD is more critical. Moreover, the case evidence seems to suggest that an R&D dominance situation is associated with high technological uncertainty. This, together with the power shifting from R&D to marketing department at the later stage of the innovation process, seems to confirm the theory that the department that possesses the most appropriate skills and the information to cope with critical uncertainty comes to have stronger influence.

In addition, the type of interface conflict, which was found to be the lack of credibility of marketing information by R&D and the lack of mutual

understanding, seems to be specifically related to the new-market and new-technology situation. Furthermore, the conflict seems to have a negative effect upon the effectiveness of the interface, especially the PTD.

5.4 R&D/MARKETING INTERFACE IN DEVELOPING SEREVENT

5.4.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

In 1987, when the development of Serevent began, the world market for asthma treatment was well established. There were 400 million prescriptions in this market each year, which was 30 per cent larger than anti-ulcer market (Glaxo source).

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

Doctors in the anti-asthmatic market were highly experienced and knowledgeable. They understood the current market situation and the limitation of the existing treatments. According to Dr Smith, a general practitioner:

"Asthma treatment has changed so much since Ventolin was invented, Most asthmatics are now well controlled during the day. The drugs available to treat them are safer and highly effective. However, asthma remains a problem in many patients; there has not been an effective inhaled drug which also has an action that keeps the lung's airways open all night (Glaxo sources)"

Although there were a few asthma treatments in the market, there had been no major new drugs for nearly twenty years. Glaxo had been a dominant competitor in this market since the launch of the first effective asthma treatment, Ventolin, in 1969. The Serevent project was started at the time when the patent for Ventolin was about to expire. The major consideration of the company was to avoid Serevent competing with its other asthmatic treatments including Ventolin and the inhaled steroids.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of asthma is relatively well known. Asthma arises from two processes in the lungs: inflammation leading to thickening of the airways and spasm of the smooth muscles causing the airways to narrow. The important fact is that the underlying inflammation is asymptomatic. Thus, even when the narrowing is reversed by bronchodilators, the inflammation can continue and worsen without the patient being aware that he or she is ill. Before Serevent, all the anti-asthma drugs were bronchodilators which only release the narrowing while leaving the inflammation untreated.

The original target of the research and development programme was to find an improved bronchodilator with longer duration of action compared with its earlier product, Ventolin. However, after the drug's additional anti-inflammatory properties were discovered at the full development stage, the goal was re-adjusted to combining bronchodilator with an anti-inflammatory action, which would make a most important advance in asthma treatment. Although the original target had been fulfilled, more clinical testing continued to accomplish the newly adjusted goal.

(ii) Side Effect (SE)

Serevent was a relatively safe drug with low side effect.

(3) Internal Technological and Marketing strength

(i) Marketing Experience (ME) and Company Reputation (CR)

Glaxo was well-known in the anti-asthmatic market owing to the success of its previous anti-asthma drug, Ventolin. The drug had been the major treatment for asthma patient since it was launched twenty years previously. Mr Railton, the Marketing Manager for Serevent, explained,

"Glaxo is already very experienced in the asthma market, is well-known by the opinion leaders, and in a strong position to take advantage of its opportunities" (telephone interview, 24th June, 1991).

(ii) Research Experience (RE) and Development Experience (DE)

Anti-asthma was a traditional and strong therapeutic area within Glaxo (see Table 1), and the research approach of Serevent was similar to that of Ventolin and Imigran. In addition, the company had developed considerable expertise in clinical trials organization and drug registration in this area since the 1960s. Nonetheless, the Serevent project presented new challenge. According to Dr Coleman, a member of the Serevent research team,

"As many of the techniques for studying bronchodilators were applicable only to drugs with a short duration of action, new test systems, which were more robust, were developed" (telephone interview, 24th June, 1991).

5.4.2 Strategic Constructs

(1) The Corporate Strategic Dimension of the Interface (CSD)

The market opportunities for Serevent were clearly identified at the corporate level with both R&D and marketing involved. Serevent was considered as strategically important for Glaxo, since it would defend the company's dominant position in the anti-asthmatic market after the patent for the company's earlier asthma drug, Ventolin, expired.

(2) The Corporate Technical Dimension

As noted earlier, Glaxo had very strong technological expertise in the anti-asthmatic therapeutic area. The Serevent project was in an existing market and applied new but related technology. The company's researchers were aware of the external technological trends in asthma treatment. Professor Clark, Dean of the National Heart and Lung Institute in London also commented that

"The chest physicians are concerned that if bronchodilator drugs are given alone, then the continuing underlying inflammation can become critical. Serevent is being introduced at a time when long-term bronchodilator treatment is being criticised. I am pleased that the Glaxo team had recognized this, and was pursuing the correct policy (Glaxo sources).

(3) The Product Strategic Dimension

In Serevent development, the multi-disciplinary project team, consisting of representatives from Clinical Research, International Medical Affairs and International Marketing, worked closely together. It had assumed major responsibilities in making such strategic decisions as the organization of the clinical trials and the formulation of promotion strategies. For instance, the Glaxo International Marketing Department held a series meetings for its local marketing groups in conjunction with the R&D department, emphasising the new drug's efficacy and the complementary relationship between serevent and inhaled steroid.

(4) The Operational Dimension

Since the asthma market was well established, a considerable amount of market data was available for detailed marketing research, such as doctors' prescribing habits, patient grouping and so on, to support strategic decision-making.

(5) The Product Technical Dimension

The interface was close and effective in deciding the presentation of the drug, including dosage form, colour and shapes of the drug. According to Dr Pilgrim, the Marketing Manager for Serevent,

*"In deciding the packaging, the dosage form and the shapes of the drug, we have provided R&D with important market information, in terms of customers tastes and preferences. For example, we introduced a new-style packaging for Serevent, i.e. the four-place Diskhaler, to match what is regarded as a revolutionary new product (see Appendix 4)"
(telephone interview, 26th June, 1991).*

5.4.3 Organizational Constructs

(1) The Interface Coordination Mechanism (ICM)

Similar to the Imigran project, the interface in the Serevent project was coordinated by the Research Management Committees (RMC) and the Product Development Committees (PDC) at the corporate level. Meanwhile, at the project level, the R&D/marketing interface was coordinated through a multi-disciplinary project team.

(2) The Interface Communication Flows (ICF) and Interface Conflict (IC)

The communication was effective especially within the project team. Dr Palmer, the Project Team Leader, recalled,

"In the past four years Serevent has been a major part of my life. I am proud of the team-work and our good communication that allowed the product to go through its development phase to British registration in four years" (Glaxo sources).

The interface in the Serevent project was relatively smooth, no major conflict was reported. According to Dr Palmer,

"Progress has not been without its hiccoughs. For example, we had disagreement with marketing on the interpretation of the clinical data, but the team's problem-solving skills smoothed out the path considerably" (Glaxo sources).

(3) Relative Influence of R&D and Marketing (RIRM)

Although the need for an improved anti-asthmatic treatment had been recognized as being strategically important for the company for sometime, the Serevent project was initiated by research. Mr Railton, explained,

"The limitation of existing therapy in the market was long recognized and improvement was needed. However, it was the research people who came up with new ideas of solving the scientific problem in this therapeutic area, which opened the possibility for such a new product" (telephone interview, 24th June, 1991).

Nonetheless, once the underlying scientific principle had been established, the market became the main driving force of the project. The marketing department exerted a strong influence from the early stage of the innovation process.

5.4.4 The Innovation Performance

(1) Development Speed (DS)

The development of Serevent took six years, which is shorter than the industry's average of eight years. Although the speed was not considered very fast as far as the whole process was concerned, the worldwide drug registration for

Serevent was carried out effectively and rapidly. Dr Tyrrell, the Head of the Regulatory Affairs Respiratory Group, recalled:

"We ensured that the 87 volumes of data were despatched speedily to regulatory staff at operating companies so that they were ready for rapid submission of their local applications. It was a remarkable achievement for copies of the IRD (International Registration Dossier) to be despatched from GGR (Glaxo Group Research) within seven working days of its being signed off at senior level" (Glaxo sources).

(2) Innovative Level (IL)

Serevent was a novel agent in established class, its innovative level was high. It also had unique features for the customers, and met their needs better than the existing products.

(3) Sales Revenue (SR)

Serevent was launched in 1991, sales in the first year were over £300 million, which was 10 per cent of the company's total sales. This indicated the drug's great potential in generating further sales revenue.

5.4.5 Summary

The same measures indicated in the previous sections are used for the environmental, strategic and organisational constructs. Following the assessment of these constructs, a preliminary discussion is provided at the end of this section. The results of this chapter will be further analysed and compared with other drug innovation cases in the cross-case analysis presented in Chapter 9.

(1) Assessment

Table 5.14 Assessment of the Environmental Constructs in the Serevent Project

Market Uncertainty					Technological Uncertainty				Internal Technological & Marketing Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	0	0	1	1	0	2	0	2	2	2	1	2	7

Table 5.15 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Serevent Project

CSD	PSD	OD	PTD
effective, but decisions were decentralized to the project team.	highly effective, responsible for many decision-making and implementation.	close and highly effective.	close and highly effective.

Table 5.16 Assessment of the Organizational Constructs in Serevent Development

ICM	ICF	IC	RIRM
Research Committee and Development Committee, project team at lower level.	Frequent and effective, esp. within project team; strong team-work.	The interface was relatively smooth, no major conflict reported.	Except for the research stage where R&D had a major influence, the whole process was market driven

Table 5.17 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Product Superiority	Sales, fbn the 1st yr
6	fast	high, novel agent in established class.	unique features for the customer, meeting the customers' needs better than competing products.	0.3

(2) Preliminary Discussion

Unlike Zantac or Imigran, Serevent was developed within the company's technological base, and it was launched in the company's existing market. The company had successfully developed an anti-asthmatic drug before. Therefore the Serevent project is a "related-technology and existing market" type of project. The market and technological conditions for the Serevent project are

shown in Table 5.14. Both the market uncertainty and the technological uncertainty were low for this project.

In spite of the drug's novel mode of action, because of its similarity to the firm's existing products, the technological uncertainty was only scored at 2 out of 6, the same level as the Zantac project (discussed in Section 5.2). The marketing uncertainty of the project was even lower, scoring 1 out of 8. Meanwhile, the company's internal technological and marketing expertise were very strong in the Serevent project (7 out of 8).

The R&D/marketing interface started early in the Serevent project, and it was most effective in the PSD, OD and PTD. However, the interface was not specifically important in the CTD. This may be because the research team possessed extensive skills and information in the company's established area, thus little uncertainty was involved. In addition, although there existed a small degree of power shifting between R&D and marketing, the innovation process was mainly market-driven with the marketing department exerting a stronger influence. The cross-functional communication was frequent, and no major conflict was reported.

On the whole, the performance of the drug development was satisfactory, in terms of the innovative level, the speed of the worldwide approval and the sales. According to Calantone and Cooper (1981) the success rate for such projects is very high. The chance to succeed for Serevent was even greater because of the lack of direct competition, which is usually associated with a well established market.

This case seems to suggest that the overall R&D/marketing interface tends to be more smooth and effective in a "close-to-home" project. This may be because both marketing and R&D are more sure about what information and services they can provide for each other and how to obtain them. The case evidence also indicates that in a "close-to-home" project, the interface tends to start early, and is likely to be market-driven. Finally, the case appears to indicate that in a "close-to-home" project, the project team has greater responsibility for the decision-making as well as the implementation of the drug innovation.

5.6 FINAL ANALYSIS

Glaxo is the world's second biggest pharmaceutical company, and has been fast growing since 1980. It has the highest R&D productivity of any pharmaceutical company in the world and the highest R&D expenditure of any company in the UK. Concentration rather than diversification, is the company's corporate strategy. The result of this concentration strategy is a highly effective communication within the organization and a strong corporate commitment to drug innovation.

Despite the fact that all the three drug innovation projects analysed here were successful, they belonged to three different types of project, i.e. the "unrelated-technology and new-market" type, the "new-market and new-technology" type and the "related-technology and existing-market" type. In addition, they also had different driving forces, which were corporate management, research and marketing respectively.

However, beyond the recognition that drug innovation can be successful regardless of their types and driving forces, the case studies have further revealed a relationship between the role of the R&D/marketing interface and the changing market and technological environment.

In this section, an effort is made to relate the findings of this chapter to the three research propositions defined in Chapter 3, the theoretical framework. These are concerned with the relationships between the strategic constructs, the environmental constructs and the organisational constructs.

Proposition 1 postulates the existence of the R&D/marketing interface in one or more of the five dimensions. The three case studies have supported this proposition, in all the three drug innovation projects, the interface was present in four dimensions. However, the results revealed that the interface in the CTD was still lacking.

Furthermore, the research proposition 1 postulates a direct relationship between the environmental constructs and the strategic constructs of the R&D/marketing interface. The case studies have also provided positive evidence for this proposition. For instance, the case study results indicate that, in a project that involves very high technological uncertainty, the interface tends to start later in the process. Moreover, whilst the interface in the CTD tends to be critical in such a project, the interface in the PTD seems to be minimum. This confirms

both the important role of the interface in the exploitation of the firm's technological competence, and the weakness of the interface in providing a design link in a new- or unrelated-technology and new-market situation.

On the other hand, The case study reveals a strong interface in most dimensions and an early starting time in a "related-technology and existing market" type of project, where the environmental uncertainty especially the market uncertainty was low. However, the interface in such a project does not seem to be important in the CTD, and this would suggest that the interface need for exploiting the firm's core technological competence is relatively low in a "close-to-home" situation. The case study also reveals the greater responsibility of the project team and the presence of strong team-work in such a project.

In addition, The case studies' results have revealed a link between some of the environmental constructs and some of the organizational constructs. In particular, an R&D dominant or research-driven situation tends to be associated with high technological uncertainty. This, together with the power shifting between R&D and marketing during the innovation process, would confirm the theory that the department that possesses the most appropriate skills and information to cope with critical uncertainty comes to have stronger influence. In addition, the lack of credibility of marketing information as perceived by R&D and their lack of mutual understanding are found to be specifically related to the new-market and new- or unrelated-technology situation, and they seem to have a negative effect upon the interface effectiveness, especially the PTD.

However, while both the relative influence of R&D and marketing and the interface conflict tend to be affected by the environmental constructs, the communication between R&D and marketing seems to be more affected by the corporate management commitment regardless of the types of innovation. Specifically, the R&D/marketing interface in a project receiving a strong corporate management commitment tends to be strong due to effective communication. Moreover, the relatively lack of internal technological and marketing expertise seems to be compensated to a certain extent by this strong interface. This would confirm the importance of the R&D/marketing interface in drug innovation as well as the commitment of corporate management in encouraging effective communication.

These findings arise from three case studies associated with Glaxo plc. They will be compared with findings from other case studies in the following chapters, and further analysed in Chapter 9, the cross-case analysis.

Note

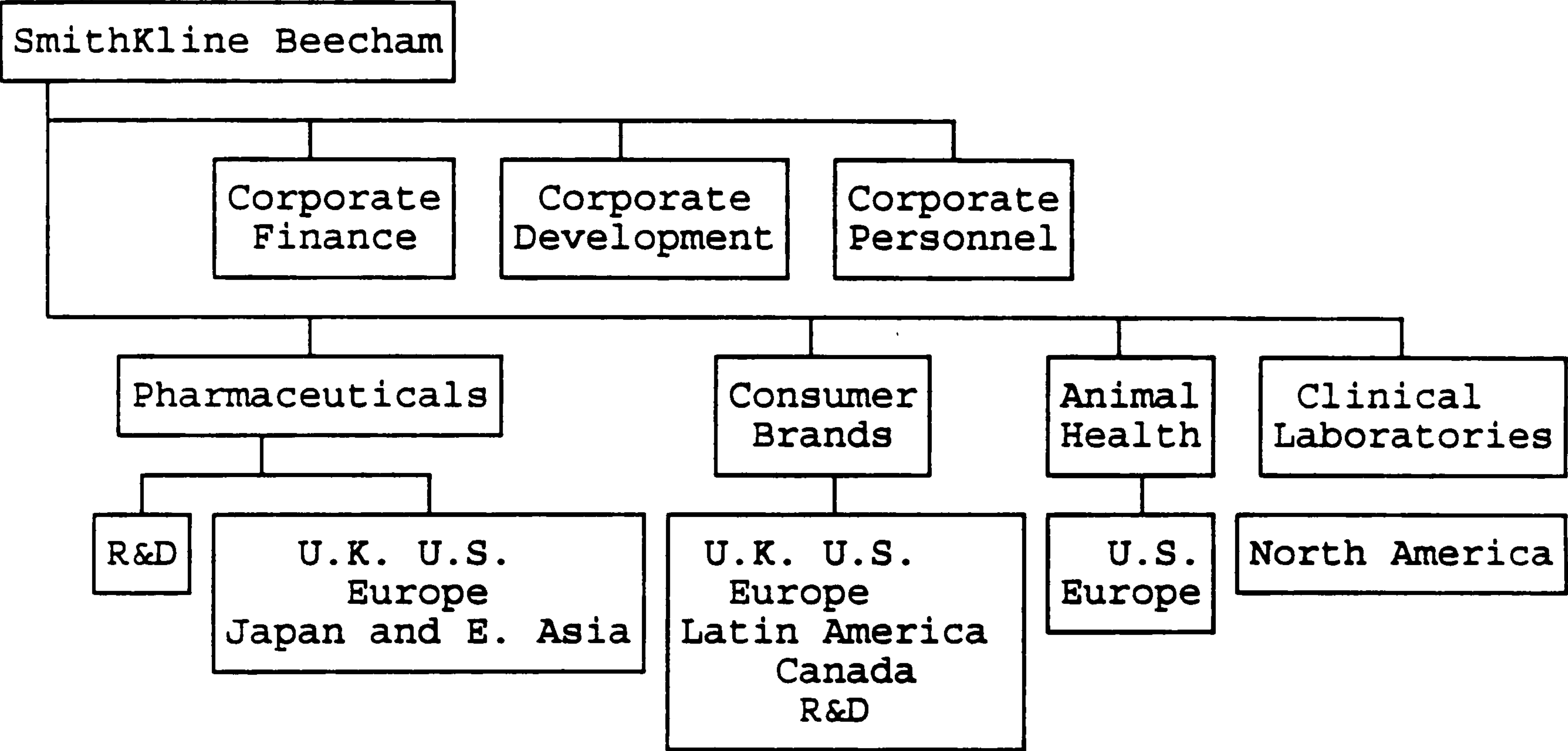
1. A chemical substance called imidazole is a major structure of Tagamet. However, Glaxo believed that imidazole was not an essential component for H₂-antagonists, and it was replaced with a furan ring.

**CHAPTER 6 THE SMITHKLINE BEECHAM PHARMACEUTICALS
CASE**

6.1 INTRODUCTION

SmithKline Beecham is a newly merged British company, which is formed from a American company, SmithKline and a British company, Beecham. Unlike Glaxo, SmithKline Beecham is highly diversified. Its organizational structure is shown in Figure 6.1.

Figure 6.1 The Company Structure of SmithKline Beecham



The company consists of four businesses - ethical pharmaceuticals, consumer brands, clinical laboratory, and animal health. The division that this case study is concerned is the ethical pharmaceuticals division. It is a major division, accounting for 50% of the company's total turnover. The division of consumer brands is the second largest business segment making up 32% of sales. The

company believes that its non-pharmaceutical businesses provide extra earnings stability and cash for research.

SmithKline was established in 1830, while its U.K. subsidiary dates from 1897. By the early 1960s, the U.K. subsidiary was the third largest supplier to the National Health Service. Its business was based on three main groups of drugs - amphetamines, psychotropics and haematinics. However, in the 1970s, the company's key products, such as amphetamines, were overtaken by newer introductions from other companies, particularly by Hoffmann La Roche's Librium and Valium. SmithKline's market share was declining.

SmithKline's wonder drug, Tagamet, launched in 1976, was developed at a time when the company needed to come up with replacements for its earlier successes. It was a significant scientific breakthrough, the first effective peptic ulcer treatment. Five years after the launch, it generated over \$800 million per year in sales, overtaking Valium as the world's largest pharmaceutical. A press comment noted:

"While not a rival to Merck in size, SmithKline with Tagamet was out of the minors and into the pharmaceutical major leagues." (Financial World, March 7, 1989).

However, since then, SmithKline had not been successful in coming up with new drugs. Despite \$330 million a year R&D investment, it had remained dependent on Tagamet. The company's R&D productivity in the 1980s was the lowest among the top ten pharmaceutical companies (see Appendix 6).

The other company, Beecham, was founded in the early 1850s. During the first century of its existence, it had a mixture of over-the-counter medicine, health drinks, and toiletries businesses. In 1957, Beecham developed the first semisynthetic antibiotics. Over the next two decades, Beecham developed several new forms of penicillin. Beecham's largest drug, Amoxil, launched in 1972, is still generating £200 million in sales annually. The company's newer product, Augmentin, is the first penicillin to overcome the problem of bacterial resistance. Nevertheless, despite its success in the antibiotics area, the company's business was too narrow, thus needed to expand.

The merger of the two pharmaceutical companies took place in July 1989. With the merger, the two companies leapt into the rank of the top five world drug companies. (see Table 6.1).

Table 6.1 The New Lineup of Drug Giants

Company	1989 sales (\$bn)
Merck	5.6
Bristol-Meyers Squibb	4.7
Glaxo	4.4
Ciba-Geigy	4.0
SmithKline Beecham	3.7

Source: James Capel & Co.

In this chapter, three products which have been developed during the past twenty years - Tagamet, Augmentin and Eminase - are studied. All the three drugs were developed and launched before the merger took place, while Tagamet was SmithKline's product and Augmentin and Eminase were Beecham's products. Figure 6.2 and Table 6.2 are the time scales and descriptions of the three products.

Figure 6.2 Product Development Time Scales

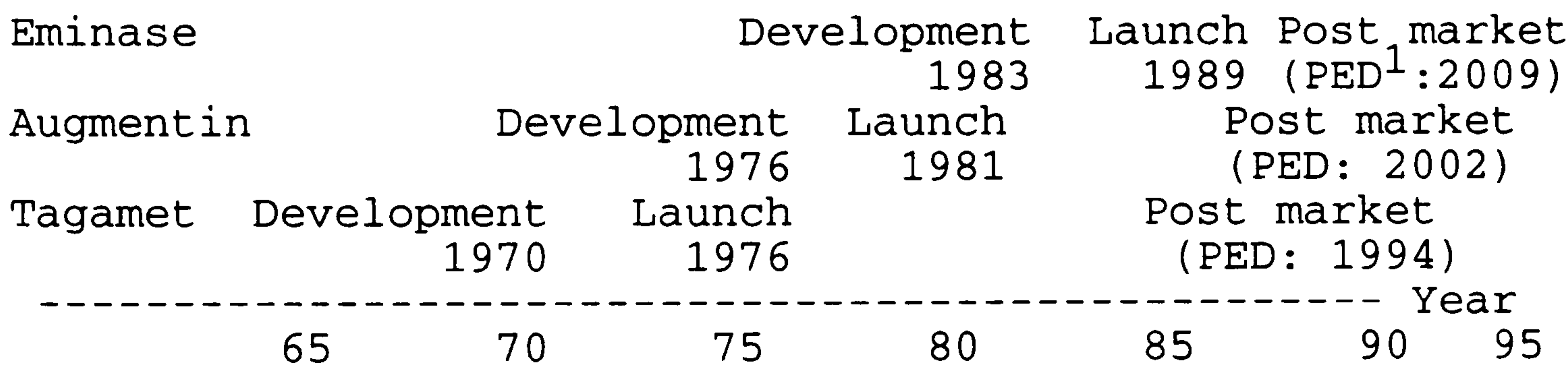


Table 6.2 Product Descriptions

Drug	Description	Innovation Level
Tagamet	The first effective anti-ulcer drug. The best-selling drug for five years before Glaxo's Zantac took over.	Very high. First drug in class.
Augmentin	An improved antibiotic drug, tackling the resistance problem found in using penicillin.	Moderate/High. Novel agent in established class.
Eminase	An injectable heart-attack treatment. It failed to show its advantages over the rivals, and sales were low.	High. Early entrant in a new class

6.2 R&D/MARKETING INTERFACE IN DEVELOPING TAGAMET

6.2.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Before Tagamet, there was no effective treatment for peptic ulcers. Surgery was often needed for persistent ulcer patients. The market was very new and was predicted to have a big potential owing to a large number of ulcer sufferers.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

There was no direct competition when Tagamet was being developed, the major objective of the company was to stimulate primary demand in the market. Meanwhile, although there was a perceived customer need for an effective anti-ulcer drug, this need was poorly defined and customers were generally cautious about such a treatment. According to Mr. Brimlecombe, the then Product Manager in SmithKline's Italian company,

"Patients' attitude was rather conservative in terms of the safety of the drug. people were quite prepared to take a risk on surgery, but with drugs, they expected 100% certainty" (SmithKline Sources).

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of the disease was not clear. Histamine was known to be involved in the normal secretion of acid into the stomach. However, exactly how histamine worked on the acid production was not known.

By adopting the principle of "beta-blockers", SmithKline discovered the link between histamine and acid secretion - the H2 receptor. This led to the development of the first H2 antagonist, Tagamet.

(ii) Side Effect (SE)

The main drawback of the drug was its poor interaction with several other drugs. However, little could be done by the company to overcome this disadvantage, because such an attempt would affect the drug's basic chemical structure. According to Dr. Leonard, Pharmaceutical Development Manager for Tagamet,

"the side effects of Tagamet could not be modified without changing the molecule of the compound, that is to say, you need to find another compound" (face-to-face interview, 18th May, 1991).

(3) Internal Technological and Marketing Strength

(i) Marketing Experience (ME) and Company Reputation (CR)

Despite the fact that the company had no previous marketing in the anti-ulcer market, it had achieved high customer awareness for the new drug by openly publicising the drug's progress from the early stage of the development. As a result, when the drug was ready for launch, most medical professionals worldwide knew about the drug.

(ii) Research Experience (RE) and Development Experience (DE)

The company had no previous experience in anti-ulcer drug development. However, the research approach was derived from the discovery of beta-blockers, where all the three key researchers in the Tagamet programme had participated prior to joining SmithKline.

6.2.2 Strategic Constructs

(1) The Corporate Strategic Dimension of the Interface (CSD)

Tagamet was developed in the company's U.K subsidiary. Corporate management located in the US had limited involvement and the interface between the local R&D group and the central marketing was minimal.

(2) The Corporate Technical Dimension of the Interface (CTD)

Similarly, there was no R&D/marketing interface in this dimension. However, unlike some of the science-driven projects where R&D was the sole initiator, the Tagamet project was partly initiated by the corporate management through its strong support for a novel approach and the recruitment of the key researchers into the company.

Since the Tagamet project involved the discovery of new scientific knowledge beyond the company's existing technologies, such corporate initiatives proved to be vital. According to Dr Sime, Director, Strategic Product Development Division,

"The top management decided to let Dr Paget and later Dr Black try this new approach, which had been rejected by ICI as being too speculative. This decision proved to be critical in Tagamet's success. Dr Black later received a Nobel Award for his work regarding this project" (face-to-face interview, 18th May, 1991).

(3) Product Strategic Dimension of the Interface (PSD)

The interface between the local R&D group and the local marketing department was close, especially at the later stage of full development in determining promotional strategies. Technical data were used to convince the customers

about the efficacy of the new drug and its significant advantage over the surgery. According to Dr Leonard,

"We conducted all the works here in the UK, it was an exciting experience for everyone involved, not just our department but the commercial department as well" (face-to-face interview, 18th May, 1991).

(4) Operational Dimension of the Interface (OD)

Some qualitative marketing research was carried out to identify the market potential and consumer attitude. However, little quantitative data were obtained such as the number of prescriptions for peptic ulcers, doctors' prescribing habits and so on.

(5) Product Technical Dimension of the Interface (PTD)

There was not close interaction between R&D and marketing in this dimension, most of the decisions, such as the design of an anti-moisture package for the drug, were made on the basis of R&D considerations.

6.2.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

SmithKline was a highly centralized company. The UK research laboratory which developed Tagamet was the only non-US laboratory doing fundamental research. The organizational structure was bureaucratic, which imposed an extra layer of management between the UK subsidiary and its headquarters. In addition, when Tagamet was being developed, the company did not have a project team structure at the time, and the interaction was on an *ad-hoc* basis. Nevertheless, the local (UK) marketing department had a close relationship with R&D, since their offices were in the same building.

(2) Interface Communication Flows (ICF) and Interface Conflict (IC)

As noted earlier, communication was relatively effective within the UK subsidiary. Nevertheless, marketing's role was mainly seen by R&D as sales promotion. Thus they had no initiative to interact with marketing on technical issues. According to Dr Leonard,

"Tagamet was a significant scientific breakthrough, marketing had an important role to play, such as the generation of promotional materials, but that was only after the technical problems had been solved by us" (face-to-face interview, 18th May, 1991).

(3) Relative Influence of R&D and Marketing (RIRM)

The project was research-driven until the pre-launch stage when marketing started to exert some influence. Moreover, the R&D department also carried out some marketing activities, such as the organization of seminars and symposia for medical professionals. According to Dr Sime,

"The research laboratory in the UK was very active, they set up a series of symposia at the 300-odd postgraduate centres in the UK where doctors normally update their knowledge - and this was even before the company was certain it had a product to sell. One of the important point which they had to get over was that Tagamet was not just another antacid, but really represented an important pharmacological breakthrough" (face-to-face interview, 18th May, 1991).

6.2.4 The Innovation Performance

(1) Development Speed (DS)

The Tagamet project was accomplished relatively fast, it took six and half years, compared with the industry's average of eight years.

(2) Innovative level (IL)

Tagamet was the first entrant to a new market and a new class of drug. The innovative level was very high. However, although it was perceived by the customers as an effective ulcer treatment, customers were concerned with the drug's side effects.

(3) Sales Revenue (SR)

Tagamet achieved a high sales revenue during the first several years. In 1981, just five years after launch, it generated £800 million in sales and became the world's best-selling drug. However, since then, sales of Tagamet began to

decline. In 1991, it generated merely £630 million, comparing with its rival - Zantac's sales of £1,600 million.

6.2.5 Summary

Qualitative measures, such as the checklists method, are used to assess the research constructs in this chapter. The results are presented in Tables 6.3 to 6.6, they will be further analysed with other case studies results in Chapter 9, the cross-case analysis.

(1) Assessment

Table 6.3 Assessment of the Environmental Constructs in the Tagamet Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	2	1	0	3	2	2	1	5	0	1	1	0	2

Table 6.4 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Tagamet Project

CTD	OD	PSD	PTD
was minimal, but corporate initiative was present.	limited to qualitative methods, and mainly for the purpose of identifying market potential.	effective in generating promotional materials.	only a weak presence.

Table 6.5 Assessment of the Organisational Constructs in the Tagamet Project

ICM	ICF	IC	RIRM
Disciplinary structure and no project team, informal at <i>ad hoc</i> basis.	In-frequent between the subsidiary and the headquarters; but frequent within the subsidiary.	R&D had a restricted view on the role of marketing.	Research driven during most of the innovation process, and marketing started to have a stronger influence at pre-launch stage.

Table 6.6 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, £bn	
				5th year	15th year
6.5	relatively fast	very high, first entrant in a new class	it was the only effective ulcer treatment, but was held back by its relatively high side effect.	0.8	0.63

(2) Preliminary Discussion

Tagamet was the first effective pharmaceutical treatment for ulcer patient and its development involved discovery of important principle of drug treatments. Thus it belonged to a "new-technology and new-market" type of project. The market and technological conditions for the Tagamet project are shown in Table 6.3. While the market uncertainty for the project was moderately high, scoring 4 out of 8, the technological uncertainty was very high, and was scored 5 out of 6. In addition, the company's internal technological and marketing expertise were not strong in the Tagamet project (2 out of 8). All these are very similar to the Imigran project discussed in previous chapter, the Glaxo Case.

The R&D/marketing interface presented in two out of five dimensions. They are the PSD and OD. The interface in both the CSD and the CTD did not exist, mainly because of the geographic distance between the central marketing (US) and the local (UK) R&D. However, the ability and initiative of the corporate

management in identifying the scientific and technological opportunities were critical for the project. R&D dominated during most of the innovation process, and the marketing only began to have a stronger influence at the pre-launch stage. The R&D/marketing interface also started late. The communication was relatively frequent between the local marketing and R&D, and the drug innovation performance was satisfactory during the first five years, both in terms of the innovative level and the sales revenue.

Unlike the Imigran project, this case did not demonstrate a strong interface in the CTD. Instead, the corporate management played a critical role in this dimension. On the other hand, similar to the Imigran project, the case evidence seems to suggest the association between an R&D dominance and high technological uncertainty.

In addition, the interface conflict was found to be the lack of credibility of marketing information perceived by R&D. It seemed to be caused by both the poor marketing research techniques and the R&D's restricted view about the role of marketing. Furthermore, the conflict seemed to have a negative effect upon the effectiveness of the R&D/marketing interface, especially the PTD.

6.3 R&D/MARKETING INTERFACE IN DEVELOPING AUGMENTIN

6.3.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Augmentin was developed to eliminate the resistance problem found in using penicillin. It was targeted at the well established antibiotic market, the total sales was £600 million in 1981 when the drug was launched.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

Since penicillin was first used, it had caused the problem of bacterial resistance in some patients. Doctors were concerned with this problem, and would welcome a solution.

Meanwhile, Beecham had been a market leader in the antibiotic market with its world number one antibiotic - Amoxil. The competitive pressure was mainly within the company to prevent the new drug attacking its own best product. According to Dr Sime,

"Beecham already had the world's number one antibiotic - Amoxil. Everything Beecham did to develop Augmentin attacked its own number one drug. How could you make Augmentin grow without killing Amoxil was a big marketing problem" (face-to-face interview, 18th May, 1991).

This strategy was later changed when more competing product were launched in the market.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of infection being bacterial was well known. However, penicillin, the effective antibiotic, was found ineffective in some patients because their body generated a resistance to the drug. The cause of this resistance problem was not clear.

Beecham's R&D discovered that the cause of the resistance problem is the secretion of bacterial called beta lactamase in penicillin. Therefore Augmentin was developed with a novel mode of action - the combination of a beta lactamase inhibitor with an antibiotic product - so as to loose the full activity of the antibiotic against a wide spectrum of bacterial.

(ii) Side Effect (SE)

Augmentin was a safe drug with low side effects.

(3) Internal Technological and Marketing Strength

(i) Marketing Expertise (ME) and Company Reputation (CR)

As noted earlier, Beecham was a well-known market leader in the antibiotic market. The company's marketing expertise had been established through the development and launch of its successful penicillin products.

(ii) Research Experience (RE) and Development Experience (DE0)

One of Beecham's great scientific advances was 6ADA, which enabled the company to make a number of semisynthetic penicillins. It had developed scientific expertise in this area for more than ten years. Augmentin was the next generation in this area.

6.3.2 Strategic Constructs

(1) The Strategic Dimension of the Interface (CSD & PSD)

The corporate management of the company was highly involved in the Augmentin project in order to ensure that its best product - Amoxil would not be affected by the launch of the new drug, and most of the strategic decisions concerning the new product were made at the presence of the corporate management. For instance, distinct competitive strategies were designed for Augmentin during different stages of the product life cycle, where both marketing and R&D input had been received. According to Miss Clancy, the Director of Strategic Product Development for anti-infective product,

" The corporate interface was critical throughout the development in designing competitive strategies for the new product. For example, prior to launch, two separate marketing groups were formed for Augmentin and Amoxil. The Augmentin group focused on complicated infections, attempting to build up the sales of Augmentin without attacking Amoxil. More importantly, this interface did not stop after the launch, it is a continuing process" (face-to-face interview, 18th May, 1991).

(2) The Corporate Technical Dimension of the Interface (CTD)

The R&D/marketing interface also played a important role in evaluating the implication of the technical decision of the new drug on the firm's long term competitive position. After the cause of the resistance problem was discovered, the research team decided to develop a drug by combining a beta lactamase inhibitor with an existing antibiotic product of the company. However, difficulties raised in deciding whether or not to use its best product - Amoxil.

R&D and marketing and the corporate management cooperated closely. Detailed laboratory works as well as extensive marketing research were carried out before the decision of using Amoxil was made. This provided the company with a genuine scientific ground as well as sound marketing knowledge to achieve a technical/marketing synergy for the new product.

(3) The Operational Dimension of the Interface (OD)

Antibiotic market was well established with a considerable amount of data available. This enabled the company to conduct extensive marketing research for both strategic and technical purposes. According to Dr Sime,

"Because the resistance problem did not occur in every patient, marketing research was an important means of finding out the conditions and areas where the resistance was likely to occur in order to assess the benefit of the new product. In addition, R&D was requested by marketing to undertake in-depth research on Augmentin relating to food, speed of reaction and side effect profile of Augmentin, with the aim of creating the new product image distinct from Amoxil" (face-to-face interview, 18th May, 1991).

(4) The Product Technical Dimension of the Interface (PTD)

Augmentin had technical problems regarding its stability. Thus, certain dosage forms requested by marketing, such as capsule and muscular injection, were not achieved in the laboratory due to technical restrictions regarding the volume and the moisture sensitivity².

6.3.3 Organizational Constructs

(1) The Interface Coordination Mechanism (ICM)

Beecham had a central marketing department. the interface between it and the R&D department in the Augmentin project was coordinated by the top management. There was no formal coordination mechanism at the corporate level. At a lower level, the R&D/marketing interface was coordinated through the project team.

(2) Interface Communication Flow (ICF) and Interface Conflict (IC)

The communication between R&D and marketing was frequent but not always smooth. Miss Corkill, the former Marketing Manager who has left the company, recalled,

"We saw each other every day, there was no communication barrier between us. However, we had a few problems. For example, the way they organised the trials made it difficult for some of the emerging market condition to be considered into the drug's formulation" (face-to-face interview, 14th March, 1991).

On the other hand, R&D felt that marketing was inconsistent in their requirement, which caused disturbance to their work. Because some stability tests required a long period to complete under certain dosage forms.

(3) Relative Influence of R&D and Marketing (RIRM)

Although the need to tackle the resistance problem existed since penicillin was discovered, the project was initiated by the research people after they discovered by accident the cause of the problem. Nonetheless, once the underlying scientific principle had been established, the mainly driving force of the project became the market with a strong involvement of the corporate management.

R&D and marketing worked closely from the very early stage. At the exploratory development stage, the focus was to evaluate the long run competitive impact of the new drug; at the pre-launch stage, the focus was to differentiate the new product and to define the target market. During this process, cooperation rather than one party dominance was called out. However, R&D had a stronger influence at the drug design stage due to the technical complexity of the drug, marketing's role was very limited.

The interface remained very close after the launch. The emphasis was on sustaining and developing the drug's competitive advantage as the competitive direction changed.

6.3.4 Innovation Performance

(1) development Speed

The development speed of Augmentin was relatively fast. The project took five years, compared with the industry's average of eight years.

(2) Innovative Level (IL)

Augmentin was a novel agent in an established class. The innovative level was scored moderate/high. The drug had a differential advantage in meeting specific customer needs.

(3) Sales

Sales of Augmentin were relatively high and sustaining. Launched in 1981, it generated sales of £300 million and £410 million in 1986 and in 1990 respectively.

6.3.5 Summary

the same measures as in the previous chapter are applied to assess the research constructs in this chapter. The results are shown in Tables 6.7 to 6.10, they will be used in the cross-case analysis in Chapter 9.

(1) Assessment

Table 6.7 Assessment of the Environmental Constructs in the Augmentin Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
1	0	0	1	2	1	1	0	2	2	2	1	2	7

Table 6.8 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Augmentin Project

CSD & PSD	CTD	OD	PTD
highly effective, responsible for making most of the decisions, top management was highly involved.	highly effective, esp. in evaluating the competitive impact of the technical decisions.	close and effective, mainly for strategic purposes.	present but not very effective

Table 6.9 Assessment of the Organizational Constructs in the Augmentin Project

ICM	ICF	IC	RIRM
informal contact at corporate level and a project team at lower level.	frequent	dissatisfaction with each other's time scale.	close link during most of the process except for drug design where R&D dominated.

Table 6.10 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	sales, £bn	
				5th yr	10th yr
5	fast	moderate/high novel agent in established class.	advantageous, meeting customers' better than competing products.	0.3	0.41

(2) Preliminary Discussion

Augmentin was not first to the market and its development was within the firm's technological base. The company had successfully developed several antibiotic drugs before. Therefore the Augmentin was a "related-technology and existing market" type of project. it bears considerable similarities to the Serevent project discussed in Chapter 5, the Glaxo Case. Firstly, they all had low technological and market uncertainties. For instance, the technological uncertainty in the

Augmentin project was only scored at 2 out of 6, and the market uncertainty was even lower, scoring 2 out of 8.

Secondly, the closeness of both projects to their firms' existing products and markets was reflected by the high level of the internal technological and marketing expertise that both projects had been provided, which was scored at 7 out of 8. Apparently, both the Serevent and the Augmentin projects represented a "close-to-home" type of project. Thirdly, the R&D/marketing interface in both projects started early in the process.

However, there are also distinct differences between these two projects. Whilst in the Serevent project, the interface was most effective in the PSD, PTD and OD, the interface in the Augmentin project was most effective in the CSD, CTD and OD. This reveals a clear emphasis on project teamwork in one hand, and on strong corporate involvement on the other. This result implies that effective interface between R&D and marketing may be achieved through different combinations of effective interface dimensions.

In addition, although there existed a small degree of power shifting between R&D and marketing, neither party had a dominant influence. The communication was frequent, but a feeling of frustration on their working relationship was recalled by both parties, mainly at the later drug design stage.

On the whole, the performance of the drug development was satisfactory, in terms of the innovative level, the development speed and the sales revenue the drug achieved.

This case confirms the finding in the Serevent project that the overall R&D/marketing interface tends to be more effective in a close-to-home project. However, it failed to confirm that the interface was more smooth as well. Nevertheless, it is noted that the conflict mainly occurred at the technical level and at the later stage. This implies that not only the technological uncertainty perceived at the planning stage of the project, but also the contiguous technical problems occurred at the later stage of the project can have a major impact upon the R&D/marketing interface.

6.4 R&D/MARKETING INTERFACE IN DEVELOPING EMINASE

6.4.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Cardiovascular drugs are the largest therapeutic category in the pharmaceutical market. In 1989 when Eminase was launched, it accounted for 14.7% of the £100 billion total pharmaceutical sales. The cardiovascular market is divided into four segments: hypertension, heart failure, Ischaemic heart, and stroke.

Eminase was a treatment for the heart failure that has a fatal consequence. However, rather than targeting to the traditional customers - the cardiologists in hospitals, Eminase was targeted at the general practitioner (GP) market, which was completely new.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

SmithKline committed large investment to promote Eminase in the GP market. As a result, 96% of doctors were aware of Eminase after the launch (SmithKline source). However, GPs generally had a negative attitude toward the drug. They were too worried about mistakes and facing negligence claims, having no experience in treating heart attack patients. Normally, GPs treat them with Oxygen or heart stimulator and rush them to hospital.

Several heart attack drugs were in the market competing with Beecham's Eminase - a highly expensive drug, costing £1,200. They were Genentech's Activase (TPA) which was available for £1,600 and streptokinase, an old drug, costing £200 a shot. The competitive pressure was highly intense in that none had a clear competitive advantage against the other. (A study called ISIS-3 found that all three drugs were equally effective at keeping people alive). Except for Eminase, all the drugs were targeted at the traditional hospital market. Beecham attempted to differentiate Eminase from its competitors by using the drug's advantage in time-saving, which is crucial for heart attack patients. The drug can be administered in a five minutes intravenous injection compared several hours needed by its rivals.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of heart attacks was clear. When a patient has a heart attack, his body continues to form clots in the circulation system to stop the punctures of blood. The result is death or damage to the heart muscle through oxygen starvation. It was however still a question as to how to make a drug bust up that blood clot faster and more directly.

Eminase is a biotechnology product representing the latest advance in drug research. It is the first thrombolytic agent that can be given as a single five minute intravenous injection. The idea was to offer patients the benefit of a more specific action, longer lasting effects, and greater convenience of use.

However, the clinical data obtained from the laboratory failed to support some of these claims. The reason was not clear. According to Dr. Crowley, manager in the R&D department, who participated in the development of Eminase:

"The clinical data did not show some of the advantages that we had expected. The ISIS-3 was a disaster for us. It shown that Eminase was merely as effective as streptokinase - an old and much cheaper drug. We do not know the reason, maybe because we didn't do the right clinical studies, maybe the original findings were not correct. If we knew the reason, we would have come up with some solutions" (face-to-face interview, 25th May, 1991).

(ii) Side Effect (SE)

The side effects of Eminase were relatively high. ISIS-3 showed that 1.5% of patients receiving Eminase suffered a stroke, compared with 1.5% of those getting TPA and just 1.1% of those getting streptokinase.

(3) Internal Technological and Marketing Strength

(i) Marketing Experience (ME) and Company Reputation (CR)

Beecham was new to the cardiovascular market. Eminase was its first attempt in this market. As a result, the company was not seen as a specialist in the cardiovascular area.

(ii) Research Experience (RE) and Development Experience (DE)

As described above the company had no previous experience in developing cardiovascular treatment. Moreover, the research approach, using genetic technology, was completely new to the company.

6.4.2 Strategic Constructs

(1) The Corporate Strategic Dimension of the Interface (CSD)

The commercial evaluation and the competitive analysis of the Eminase project at the corporate level were not adequately undertaken. According to Miss Clancy,

"There wasn't a strategic interface before initiating the research programme. If there was one, Eminase may not have been developed at the first place, because it did not present long term market opportunities for the company" (face-to-face interview, 18th May, 1991).

(2) The Product Strategic Dimension

The R&D/marketing interface began from the full development stage to evaluate the commercial viability of the research-initiated new product idea.

However, although attempt was made to jointly conduct a educational programme to the customers, it was not effective in changing the negative attitudes of the GPs. Consequently, the drug's potential advantage of being time-saving through GP administration was not realised.

(3) The Operational Dimension of the Interface (OD)

The interface was not very effective in this dimension, because market information was difficult to obtain. According to Dr. Sime,

"The market for Eminase was only potential. Thus, most of the market techniques used for Augmentin could not be applied to Eminase. For Augmentin, marketing people could go and ask the doctors what products they were using to treat the infection, and to persuade them to use Augmentin instead of other products. However, when you are talking about Eminase, you are facing a group of doctors who don't treat those patients at all. We have to ask them to imagine what they would do if this product was available, how many patients could they treat, etc." (face-to-face interview, 18th May, 1991).

(4) The Product Technical Dimension of the Interface (PTD)

Eminase was a biotechnological product and was technically complex. Its dosage form was a five minute injection, which was assumed to be a big competitive advantage in the market. However, No adequate marketing research had been conducted to evaluate this pre-claimed advantage.

6.4.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

Similar to the Augmentin project, the Eminase project was developed by Beecham prior to the merger. In spite of the time lag between these two project (launched in 1981 and in 1989 respectively), there was no fundamental difference between their coordination mechanisms except for the strong corporate involvement in the Augmentin project. The central marketing department mainly assumed a implementation role rather than a strategic one, while R&D department was organized into a matrix structure - Therapeutic groups led by project managers and disciplinary departments led by department heads.

(2) Interface Communication Flow (ICF) and Interface Conflict (IC)

The communication between R&D and marketing was not very frequent and there was some degree of distrust between these two parties. According to Dr Crowley,

"I did not recall a very close relationship we had with them, and I still could not imagine in what way they would have made it more successful. Something must have gone wrong in the clinical trials. If the results of the trials had proved those advantages, the drug would be more successful" (face-to-face interview, 25th May, 1991).

On the other hand, marketing people felt that technical staff lacked of commercial sensitivity, thus they should be guided by the marketing. Miss Clancy believed the disastrous result was caused by the absence of such a guide.

(3) Relative influence of R&D and Marketing (RIRM)

Eminase was initiated by the research people who believed that their important findings on a molecule association would provide a better treatment for heart attack patients. R&D had a dominant influence during most of the development process.

6.4.4 The Innovation Performance

(1) Development Speed (DS)

The development programme took six years, which were shorter than the industry's average of eight years.

(2) Innovative Level (IL)

Eminase was a highly innovative and biotechnology-derived product, an early entrant in a new class. It won the Queens Award for technology achievement in 1990. However, in spite of its innovativeness it was not perceived by the customers as being better than competing products in satisfying their needs.

(3) Sales

Eminase did not achieve the sales figures that were expected by the company. Sales of Eminase were very low (less than £100 million in the second year) especially compared to the extremely high R&D cost involved in developing this type of drug.

6.4.5 Summary

The same measures as in the previous chapter are applied in assessing the three research constructs described above. The assessment is displayed in Tables 6.11 to 6.14, and the results will be analysed in the cross-case analysis in Chapter 9.

(1) Assessment

Table 6.11 Assessment of the Environmental Constructs in the Eminase Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	2	2	2	6	0	2	2	4	0	0	0	0	0

Table 6.12 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Eminase Project

PSD	OD	PTD
was present in evaluating the commercial viability of a research-initiated project, and later in customer education.	was present but encountered difficulties in obtaining required information.	was present but not effective.

Table 6.13 Assessment of the Organizational Constructs in the Eminase project

ICM	ICF	IC	RIRM
no formal mechanism at Corporate level, but a project team at lower level.	not frequent.	mutual distrust and marketing's lack of credibility perceived by R&D.	Mainly R&D dominated.

Table 6.14 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, £bn 1st yr
6	relatively fast	High. Early entrant in a new class	Not better than competing products in meeting customer needs.	0.1

(2) Preliminary Discussion

Eminase was not first to market, there had existed several effective treatment for heart attacks. However, the company had never developed a heart attacks drug, and the technologies required were beyond the company's technological base. As a result, the drug belonged to an "unrelated-technology and new-market" type of project. Table 6.11 shows that both market uncertainty and technological uncertainty in the project were very high, especially the market uncertainty, scoring at 6 out of 8. Meanwhile, the company lacked of internal expertise for the project (0 out of 8). All this indicate that it was a very risky project.

On the other hand, the R&D/marketing interface only weakly presented in the PSD, OD and PTD with a notable absence of a corporate interface. As a result, some critical activities such as preliminary market assessment and market research for understanding customer needs, buyer behaviour, and market potential were poorly undertaken.

The case evidence suggests an association between the poor innovation performance and the lack of the R&D/marketing interface in the corporate dimension in a new-market and new-technology type of project. This case study also confirms the association between an R&D dominant situation and high technological uncertainty. In addition, the lack of marketing's credibility found in both the Imigran and Tagamet projects has also been revealed in this case study. However, another type of conflict - mutual distrust - was also found in this project. Moreover, the latter seems to have a worse effect upon the interface than the former. Thus, the conflict of mutual distrust may categorised as the serious disharmony.

6.5 FINAL ANALYSIS

SmithKline Beecham is a newly merged UK based pharmaceutical company. The former SmithKline was very successful with its anti-ulcer drug Tagamet. However, it had a problem in developing newer drugs. Beecham, on the other hand had developed several successful penicillin products since the 1960s. However, its business needed to expand further.

All the three drugs studied in this chapter were developed before the merger. Similar to the drugs studied in Glaxo Case, they belonged to a "new-technology and new-market" type, a "related-technology and existing-market" type and an "unrelated-technology and new-market" type of project respectively. However, not all of these drug projects were successful.

The case study has confirmed the relationship between the role of the R&D/marketing interface and the changing market and technological environment, which has been first revealed in the Glaxo case. In addition, it has revealed a link between the effectiveness of the R&D/marketing interface and the innovation performance.

In this section, the findings of this chapter are related to the research propositions defined in the theoretical work, in terms of the relationships between the strategic constructs, the environmental constructs and the organizational constructs.

The research proposition 1 postulates the existence of the R&D/marketing interface in one or more of the five dimensions. The three case studies have supported this proposition. Specifically, in the Tagamet project the interface was present in the PSD and OD; in the Augmentin project the interface was present in the CSD, CTD and OD; and in the Eminase project the interface was present in the PSD, OD and PTD.

However, the case evidence indicates that, in different projects, the effectiveness of the R&D/marketing interface in these dimensions varied considerably. For example, whilst in the Augmentin project the interface was highly effective in most dimensions that it was involved, in the Eminase project the interface was only weakly present. Comparing with the innovation performance of these two projects, these findings indicate a link between the effectiveness of the interface and the innovation performance.

In addition, a direct relationship between the environmental constructs and the strategic constructs of the R&D/marketing interface is postulated in the research proposition 2. The case studies' results have supported most of the findings from the previous chapter regarding this proposition, such as the association between the effectiveness of the interface and the type of project, between the starting time and the type of project and between the driving force of the projects and the technological uncertainty.

However, the case studies failed to support the claim that the R&D/marketing interface in a "related-technology and existing-market" type of project is more smooth than in a "new- or unrelated-technology and new-market" type of project due to the low environmental uncertainties it involved. Nevertheless, it is noted that in a "related-technology and existing-market" type of project the conflict mainly occurred at the technical level and at the later stage. This suggests that not only the technological uncertainty perceived at the planning stage, but also the contiguous technical problems occurred at the later stage can have an major impact upon the R&D/marketing interface.

Finally, The case evidence has supported the association between the type of conflict and the type of project. In particular, the lack of marketing credibility as perceived by R&D and a mutual distrust are more often found in a "new- or unrelated-technology and new-market" type of project. It tends to result from the inappropriate marketing research techniques and R&D's restricted view of the marketing's role. This type of conflict has a serious effect upon the effectiveness of the interface.

These findings arise from three case studies regarding SmithKline Beecham Pharmaceuticals. They will be compared with findings from the remaining case studies in this research and be further analysed in the cross-case analysis in Chapter 9.

Note :

1. Patent Expiry Date.

2. Several years after the launch, a new dosage form was developed, which eliminated the moisture sensitivity problem of Augmentin. This new dosage form has given the company an additional three years patent protection in most countries.

CHAPTER 7 THE ICI PHARMACEUTICALS CASE

7.1 INTRODUCTION

ICI pharmaceuticals is a major subsidiary of one of the world's most diversified chemical company - the ICI Group. ICI pharmaceuticals accounts for 50% of the group profit and 27% of the turnover.

Cardiovascular is a strong therapeutic area in ICI pharmaceuticals, generating £850 million in sales in 1990. The company's ischaemic heart treatment, Inderal, launched in 1965, was the world's first beta-blocker agent. The research team was led by Dr. James Black, later to become one of the recipients of the 1988 Nobel Prize for Medicine. Table 7.1 shows the principal ICI pharmaceuticals discoveries since 1960s.

Table 7.1 Principal ICI Pharmaceuticals Discoveries 1963 - 1988

Brand name	Type	First Launch
Inderal	beta-blocker	1965
Ketrax	anthelmintic	1968
Hibiscrub	antiseptic	1971
Nolvadex	anti-oestrogen	1973
Tenormin	beta-blocker	1976
Diprivan	intravenous anaesthetic	1986
Zoladex	LHRH analogue	1987
Zestril	ACE inhibitor	1988

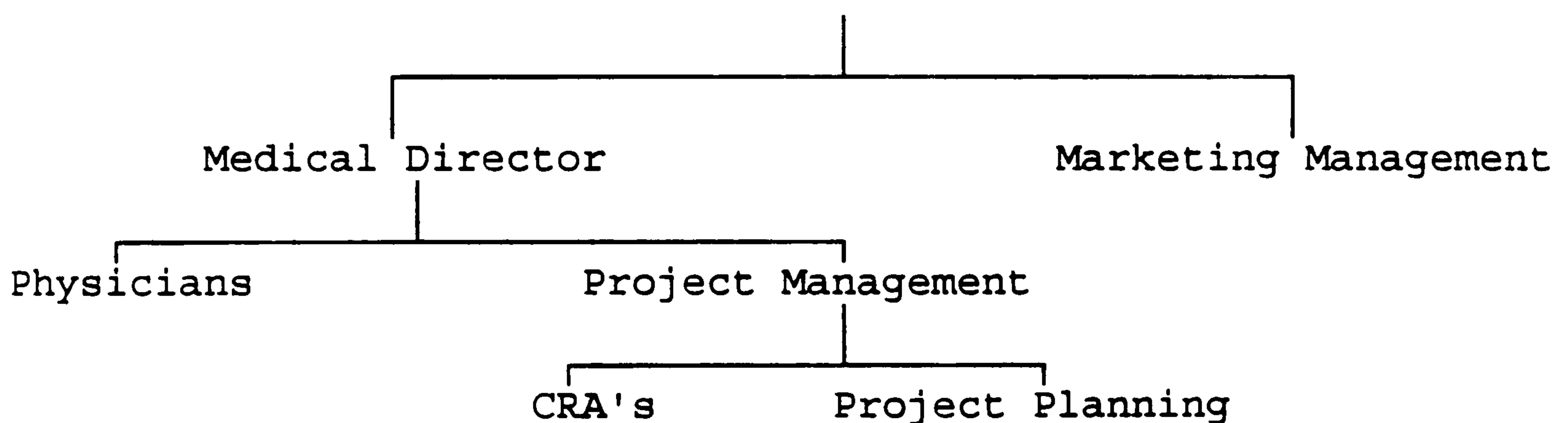
Source: ICI Pharmaceuticals

In the ICI Pharmaceuticals, R&D consists of two separate departments: The Research Department and The Development Department. It reflects the company's different management philosophy of these two departments. According to Mr Bilyard, Manager of the Product Development,

"We believe that the research needs more freedom in order to provide new opportunities for the development. On the other hand, the target of the Development Department should be more clearly defined and focused" (face-to-face interview, 14th March, 1990).

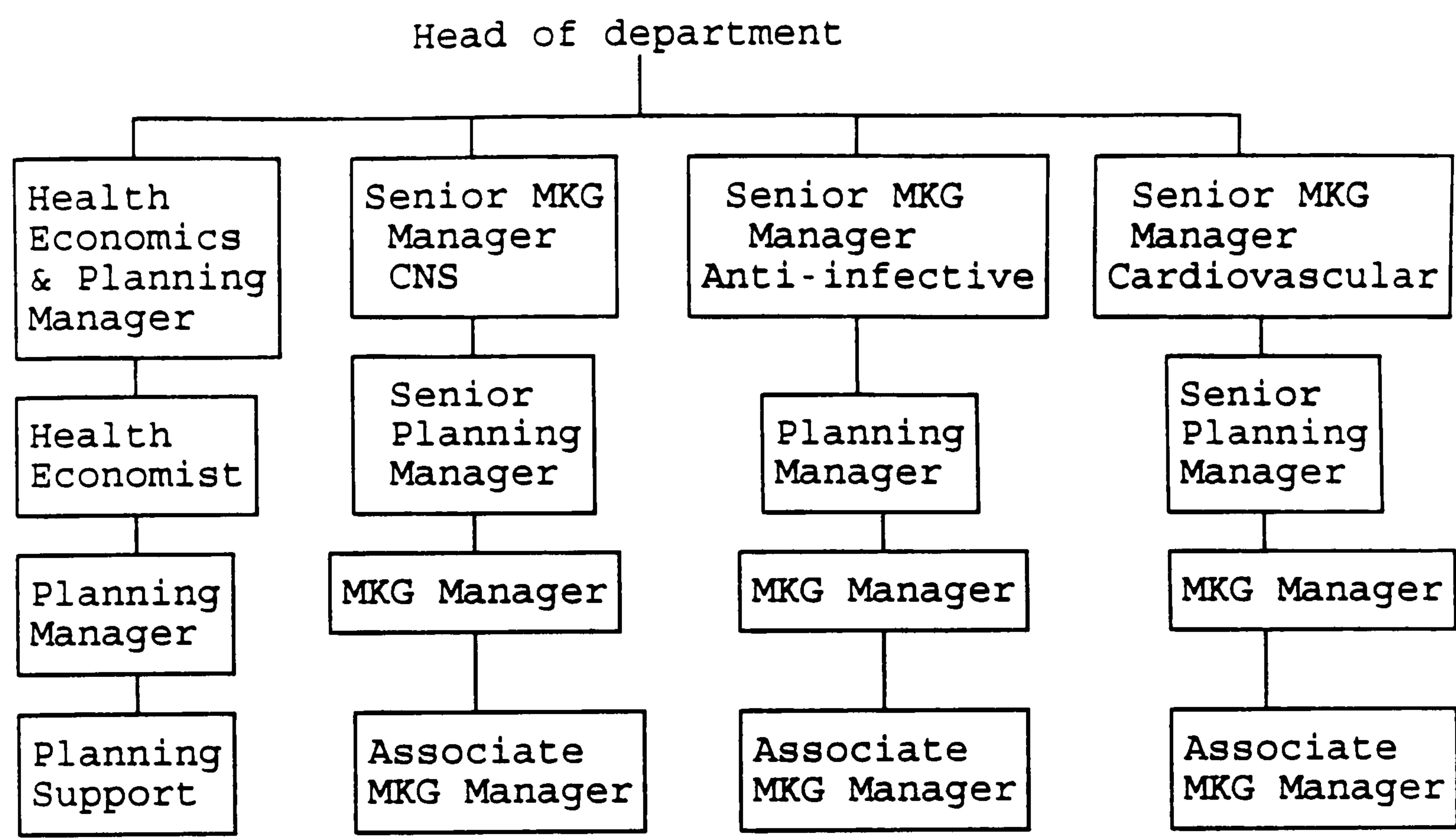
The structure of the Development Department has been re-organized since 1990. The new structure are shown in Figure 7.1.

Figure 7.1 The New Structure of Development Department



Similar to R&D, marketing in ICI Pharmaceuticals is also divided into two departments: Product Strategy Department(PSD) and Marketing Operation Department(MOD). Their names reflect precisely their departmental goals and responsibilities: strategic versus operational. The PSD is responsible for deciding long term marketing strategies for each of the therapeutic areas. On the other hand, the POD is responsible for generating market data to back up the strategic plan and for implementing the operational plan of the strategy using marketing research techniques. Figure 7.2 shows the structure of the PSD.

Figure 7.2 The Structure of the Product Strategy Department



In this chapter, three products, which have been developed during the past twenty years - Tenormin, Diprivan and Zoladex - are studied. Tenormin is a much improved beta-blocker. Launched in 1976, it became the world's number six best-selling drug in 1990, generated £640 million in sales. Zoladex is a cancer treatment and Diprivan is an intravenous anaesthetic. They received the Queens award for Technology Achievement in 1978 and 1992 respectively.

The criteria for choosing the products have been described in Chapter 2, the research methodology. The structure of analysis is identical to that in previous chapters which focuses on the relationships between the environmental constructs, the strategic constructs and the organisational constructs. Tables 7.2 and 7.3 show the time scales and descriptions of these three products.

Table 7.2 Product Development Time Scales

Zoladex	Development	Launch	Post market						
	1976	1987	(PED:2000)						
Diprivan	Development	Launch	Post market						
	1974	1986	(PED:1998)						
Tenormin	Development	Launch	Post market						
	1967	1976	(PED: 1991)						

	1960	65	70	75	80	85	90	95	Year

Table 7.3 Product Descriptions

Drug	Description	Innovative level

Tenormin	A Hypertension treatment. The first successful cardio-selective beta- blocker.	Moderate/high. Novel agent in established class.

Zoladex	The first effective drug for prostate cancer, with a new delivery system - a monthly injection.	High. Novel agent in growing class.

Diprivan	An intravenous anaesthetic, its main property is its applicability in all three anaesthetic situations.	Moderate/high. Novel agent in established class.

**7.2 THE R&D/MARKETING INTERFACE IN DEVELOPING
TENORMIN**

7.2.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Tenormin was launched in 1976 in the well established cardiovascular market. It is the biggest market in the pharmaceutical industry, consisting of four segments: hypertension, heart failure, Ischaemic heart, and stroke.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

Tenormin is a hypertension treatment. Customer need awareness for this kind of drug had been relatively low before the drug was launched. Mr Joseph, the International Planning Manager for cardiovascular products explained,

"Hypertension is asymptomatic. The reason for treating it is to prevent problems such as heart attack later on, which is rather like an insurance policy. Patients were reluctant to take any medication that would make them feel even worse"
(face-to-face interview, 14th March, 1990).

However, Tenormin was launched at the time when a debate on the level at which hypertension should be treated was intensified, and the trend was both to increase treatment and to favour the use of beta-blocker.

There were several effective hypertension drugs competing with Tenormin, including the company's own product, Inderal, Ciba-Geigy's Trasicor and Astra's Betaloc. Nonetheless, there were perceptible customer needs for a new drug which could offer the customers the benefit of lower side effects and more convenience in use.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of hypertension was relatively clear. It is related to the abnormal level of ACE (angiotensin-converting enzyme) in the hormonal system.

Tenormin is the first cardio-selective beta blocker. it has a novel mode of action. Its two main properties - cardio-selectivity and hydro-philicity - provided the patients with low side effect and a long duration of action.

(ii) Side Effect (SE)

One of the major achievements of the Tenormin project was the drug's low side effect, which was extremely important for the asymptomatic hypertension treatment. The project succeeded after the company's earlier attempt Eraldim

failed due to the incidence of eye problems which occurred in a few patients taking the drug.

(3) Internal Technological and Marketing Strength

(i) Marketing Expertise (ME) and Company Reputation (CR)

The company was well-known in the cardiovascular market with its earlier success, Inderal, launched in 1965. Although Inderal was not originally developed for hypertension, its later application in hypertension market enabled the company's marketing expertise in this area to be developed.

(ii) Research Experience (RE) and Development Experience (DE)

As noted earlier, Tenormin was the first cardio-selective beta-blocker, a new but related agent to the company's earlier product, Inderal. Thus, the company had obtained considerable research and development experience in this field.

7.2.2 Strategic Constructs

(1) The Corporate Strategic Dimension of the Interface (CSD)

Tenormin was not given a high priority until its potency was discovered later in the development. It was overshadowed by the company's then successful cardiovascular product - Inderal. Mr Joseph recalled,

"Because of Inderal, Tenormin was expected only as the second best by the company. The company only began to realize the drug's big potential close to the launch, and it started to get very involved" (face-to-face interview, 14th March, 1991).

(2) The Corporate Technical Dimension of the Interface (CTD)

The Tenormin project represented the orientation of the company's "incremental" technological strategy. The goal of the project was to develop an

improved beta-blocker for treating hypertension after the company's earlier success in this area.

(3) The Product Strategic Dimension of the Interface (PSD)

The interface activities in this dimension were focused on differentiating Tenormin from the existing products in the market. The major task was to create the image of Tenormin as a superior product. According to Mr Joseph,

"competitive strategy was designed to differentiate Tenormin from other beta-blockers and to prove that its technical advantages, namely the cardio-selectivity and hydro-philicity, could offer major benefit to the customers" (face-to-face interview, 14, March, 1991)"

(4) The Operational Dimension of the Interface (OD)

Cardiovascular market was the company's traditional market, the marketing department had mastered mature data collecting techniques. Quantitative as well as qualitative data were collected to support the strategic decision-making regarding the product differentiation and competitive analysis.

(5) The Product Technical Dimension of the Interface (PTD)

The interface in this dimension was weak before the launch and became close and effective after the launch. For example, a new formulation named Tenoretic, which combined the new drug and Dinetic, was developed to target to a newly identified market needs. Lower dosage was developed to meet new customer needs as the trend in the hypertension market was moved towards early treatment.

7.2.3 Organisational Constructs

(1) The Interface Coordination Mechanism (ICM)

There was no formal interface channel at the corporate level in the Tenormin project. The interface at the lower level was coordinated through project team.

(2) The interface Communication Flow (ICF) and Interface Conflict (IC)

The communication between R&D and marketing was relatively effective, and no major conflict was reported during this process. According to Mr Joseph,

"We had frequent discussion with the clinical people at the pre-launch stage regarding the drug's technical advantages and their benefit to the customers, which was rather fruitful" (face-to-face interview, 10th September, 1991).

(3) Relative Influence of R&D and Marketing (RIRM)

The initiative of Tenormin research programme was the technical people who had great interest and faith in beta-blocker and were motivated to prove it. Research remained the main drive till the pre-launch stage, where the corporate management and marketing began to exert a stronger influence. The drug's market potential was largely exploited at the post market development stage, where market became a main driving force.

7.2.4 The Innovation Performance

(1) Development Speed

Tenormin development programme took eight years, which were the industry's average time for drug development.

(2) Innovative Level (IL)

Tenormin is a cardio-selective beta blocker for hypertension treatment. It is a novel agent in an established class. The innovative level was moderate high, and the drug was perceived by the customer as superior in meeting customer needs.

(3) Sales

The commercial success of Tenormin was achieved gradually within a period of ten years. Launched in 1976, by 1990, it generated £630 million in sales and

became the world's number six best-selling drug. It was developed into four major indications. It's success is much higher than the company's original forecast of peak sales of £100 million.

7.2.5 Summary

As noted earlier, the same measures are used in every drug innovation case to assess the three research constructs defined in the theoretical framework. The assessment is presented in Tables 7.4 to 7.7. The results will be compared with other case results in the cross-case analysis in Chapter 9.

(1) Assessment

Table 7.4 Assessment of the Environmental Constructs in the Tenormin Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	0	1	2	3	1	1	0	2	2	2	2	1	7

Table 7.5 Assessment of the Strategic Constructs in the R&D/Marketing Interface in the Tenormin Project

CSD	CTD	PSD	OD	PTD
effective, but relatively later, when top management began to get involved.	not present, top management provided a direction.	highly effective in product differentiation.	effective	weak before launch.

Table 7.6 Assessment of the Organizational Constructs in The Tenormin Project

ICM	ICF	IC	RIRM
no formal mechanism at the corporate level; project team at the lower level.	relatively effective at the pre-launch stage.	relatively smooth.	mainly research driven. But the top management and marketing had a stronger at pre-launch stage.

Table 7.7 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, £bn 5th yr 15th yr
8	relatively slow	moderate high, novel agent in an established class.	Superior in meeting customer needs.	0.63

(2) Preliminary Discussion

Similar to Glaxo's Serevent and SKB's Augmentin, Tenormin was a "related-technology and existing-market" type of product. It is most notable for its similarity to the company's existing products and its closeness to the existing markets, which are reflected by the high internal expertise (scoring 7 out of 8).

Both market uncertainty and technological uncertainty for this project were relatively low, scoring 3 out of 8 and 2 out of 6 respectively (see Table 7.4). However, the market uncertainty for the Tenormin project was comparatively high than the two similar projects mentioned above, because of the high market competitiveness the project faced. Nevertheless, there was a good balance between the market uncertainty, the technological uncertainty, the internal expertise and the commercial attractiveness of the product. Similar to the Serevent project, the communication between R&D and marketing was relatively effective and smooth. No major conflict was reported.

However, unlike the other similar projects, the project was mainly research-driven, and the R&D/marketing interface started later in this project. This seems to suggest an association between a driving force of research and a later starting time for the interface, in addition to the association between a high technological uncertainty and a research-driven project, which has been suggested by the earlier case study results.

The interface was most effective in the PSD and OD before launch, and was extended to most dimensions at the post market stage when the sales of the drug were gradually increasing. This suggests a link between a high drug innovation performance and an effective R&D/marketing interface. In other words, a lack of corporate involvement and marketing involvement at the early stage had resulted in a delayed recognition as well as a delayed realization of the product's commercial potential.

7.3 THE R&D/MARKETING INTERFACE IN DEVELOPING DIPRIVAN

7.3.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Diprivan, launched in 1986, was targeted at the well established anaesthetics segment within Central Nerves System (CNS) market. Anaesthetics are used by anaesthetists in hospital for three purposes. The first one is to put a patient to sleep before an operation begins; the second is to maintain the sleep status of the patient for certain length of time according to the requirement of the operation; and the third is for Intensive Care Unit (ICU).

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

there were several major competitors, including thiopetone, an off-patent drug, Abbot's Isoslurane and Roche's Midazolom. However, although these drugs were very effective in each individual area, none could be used in the same way

as Diprivan for all three areas. Therefore, with its important three-in-one property, Diprivan was welcomed by the anaesthetists.

(2) Technological Uncertainty

(i) Mode of Action (MA)

Diprivan is a intravenous anaesthetic. Its main ingredient is a chemical substance called propofol. Propofol was discovered in the research laboratory of having an encouraging anaesthetic property, which, however, has poor water solubility. A formulation (Cremophor EL) was therefore developed to solve this problem. As indicated earlier, the drug also had a three-in-one property, which was realized just before the launch.

(ii) Side Effect (SE)

In few patients, Diprivan may cause anaphylactoid reactions. According to ICI sources, in a clinical trial programme, anaphylactoid reactions were reported in five patients anaesthetised with propofol.

(3) Internal Technological and Marketing Strength

(i) Marketing Expertise (ME) and Company Reputation (CR)

Anaesthetic market was not new for ICI. Before Diprivan, the company had successfully developed an inhalational anaesthetic named Fluothane. Thus the company had achieved a good reputation in this area.

(ii) Research Experience (RE) and Development Experience (DE)

Having developed an inhalational anaesthetic, the company had gained considerable experiences in the anaesthetic market. However, new technical challenge regarding the drug's solubility confronted the technical staff in their attempt to develop the company's first injectable anaesthetic.

7.3.2 Strategic Constructs

(1) Corporate Strategic Dimension of the Interface (CSD)

The Diprivan project was evaluated against the company's long term strategic plan at the planning stage. However, the corporate management was not highly involved thereafter.

(2) Corporate Technical Dimension of the Interface (CTD)

The Diprivan project was another manifestation of the company's "incremental" technological strategy following the Tenormin. Furthermore, the corporate management was able to quickly adapt the opportunity emerged during the research process. According to Dr Costello, Manager of Pharmaceutical Development Department for CNS Product,

" After the launch of our earlier inhalational anaesthetic - Fluothane, the company's initial plan was to develop an improved inhalational anaesthetic. As the research proceeded, more information were available, the company made the central decision to switch to finding an injectable anaesthetic" (telephone interview, 21st May, 1991).

Critical information and input had been received from both marketing and R&D in making this decision.

(3) Product Strategic Dimension of the Interface (PSD)

R&D and marketing cooperated closely at the pre-launch stage to utilise the drug's "three-in-one" property that they had realised to convince the customers the superiority of the new drug to the existing ones.

(4) Operational Dimension of the Interface (OD)

Market research was highly effective, apart from the company's own marketing department, external expertise were used for marketing research and promotional campaign for the U.K. market and overseas markets. For instance, a marketing company called Price Waterhouse Urwick conducted a survey analysing the size of the market for anaesthetic in Australia.

(5) Product Technical Dimension of the Interface (PTD)

Difficult technical problems regarding the new compound's solubility and stability prevailed at the later development stage, and marketing was not highly involved to provide assistance to the technical problem-solving.

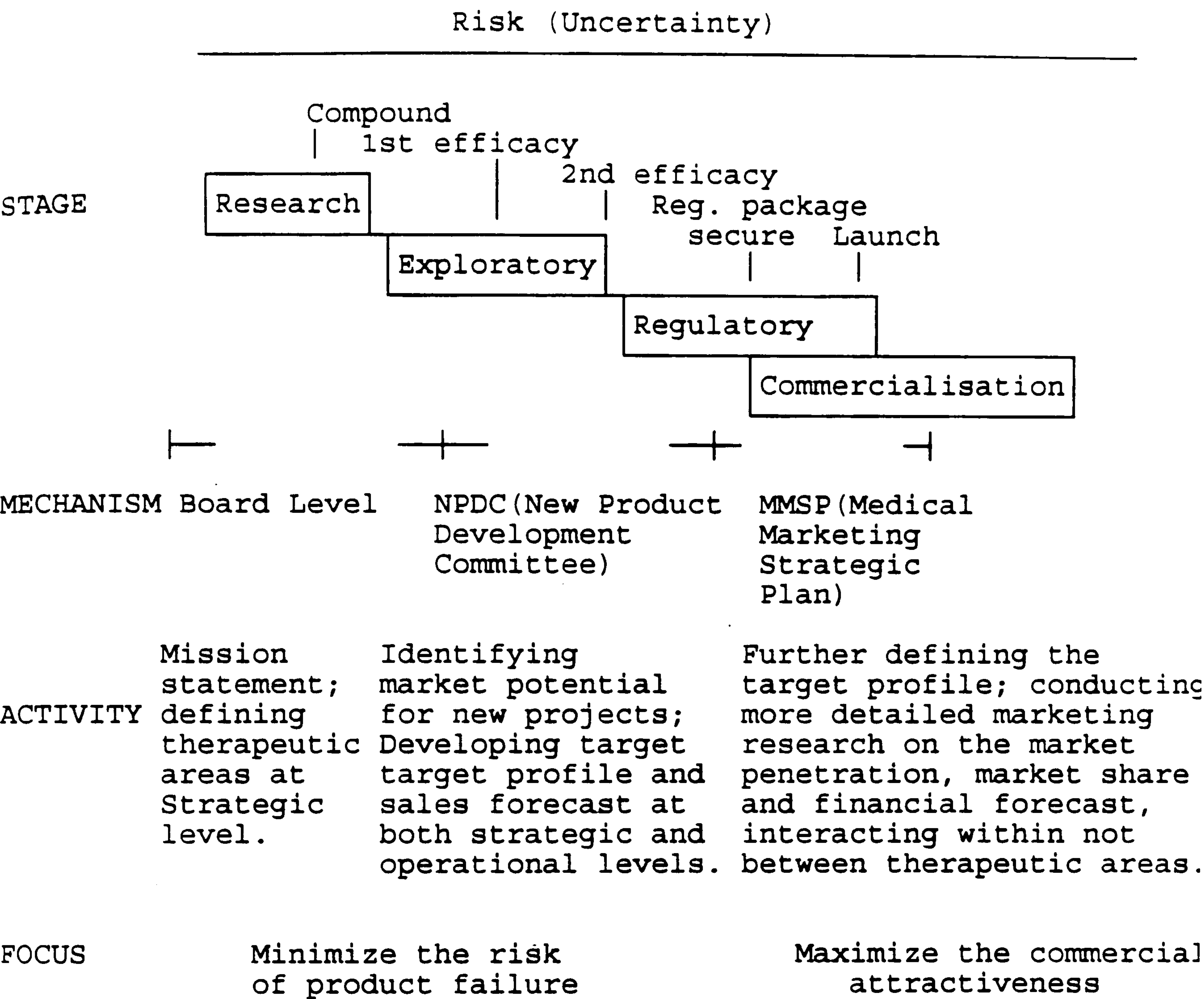
However, the interface became close at post market stage in developing new indications for the drug, and included a new indication for patients aged 16 and under in the intensive care unit.

7.3.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

Since 1985, the structure of ICI Pharmaceuticals had been re-organised. When Diprivan was being developed, formal interface mechanisms were established at the corporate level, including Board Meeting, New Product Development Committee (NPDC) and Medical Marketing Strategic Plan (MMSP). They were responsible for interface activities at various innovation stages (see Figure 7.3)

Figure 7.3 The Formal Corporate Interface Mechanism



Similar to the Tenormin project, the Diprivan project also had a multi-functional project team.

(2) The Interface Communication Flow (ICF) and Interface Conflict (IC)

The communication flow pattern between R&D and marketing was irregular. It was frequent during the later research stage and early development stage, and during the product launch. According to Dr Costello,

"We communicated well with the marketing department during the product launch, through various channels. These included both formal and informal meetings 3-4 times a week, an electronic mailing system, and participation on each other's seminars" (telephone interview, 21, May, 1990).

However, conflict occurred during the later development stage when marketing felt being pushed away by R&D, and were dissatisfied with R&D's prolonged time scale.

(3) Relative influence of R&D and Marketing (RIRM)

The development of an improved inhalational anaesthetic was stressed in the corporate plan. The R&D/marketing interface in the corporate dimension was close and effective in adapting emerging opportunity in the research laboratory. However, the process became more R&D dominant at the development stage when the main focus shifted to deal with the technical difficulties derived from the drug's poor solubility.

7.3.4 The Innovation Performance

(1) Development Speed (DS)

The development programme of Diprivan lasted for approximately eleven years, which were much longer than the industry's average of eight years.

(2) Innovative level (IL)

Diprivan was a novel agent in an established class. The innovative level was scored moderate/high, and it was perceived by the customers as being superior to the competing drugs.

(3) Sales

Diprivan's unique advantage of "three-in-one" was not realized until the pre-launch stage. Its sales revenue was gradually built up during a course of six years, and in 1991, the sales figure exceeded the original peak sales forecasting of £107 million when there were still several new markets for the drug's launch including Japan. The drug is likely to become the world number one anaesthetic.

7.3.5 Summary

In this section, the Diprivan case is assessed in the same way as in the previous cases. The assessments on the environmental constructs, strategic constructs and organisational constructs are shown in Tables 7.8 to 7.11. The results will be compared and further analysed in Chapter 9.

Table 7.8 Assessment of the Environmental Constructs in the Diprivan Project

Market Uncertainty					Technological Uncertainty				Internal Technological & Marketing Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
1	0	0	2	3	0	1	1	2	2	2	1	1	6

Table 7.9 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Diprivan Project

CSD		CTD		PSD		OD		PTD
present but the top management was not involved.		highly effective in adopting emerging opportunities arising from the research laboratory.		highly effective in designing launching strategy.		highly effective		weak

Table 7.10 Assessment of the Organisational Constructs in the Diprivan Project

ICM	ICF	IC	RIRM
New Product Development Committee, Medical Marketing Strategic Plan and Project Team. innovation.	Relatively frequent.	Marketing's dissatisfaction of R&D's time scales.	A close link at the early stage, but research driven at the later stage.

Table 7.11 Assessment of the Innovation Performance

DT (yrs)	DS	Innovation Level	Superiority	Sales, fbn 10th yr
11	Slow	moderate/high novel agent in established class.	Advantageous, meeting customers' needs better than competing products.	0.2 (estimate)

(2) Preliminary Discussion

Similar to the company's earlier hypertension drug, Tenormin, Diprivan was another "related-technology and existing-market" type of project. The internal expertise in developing the drug was relatively high, scoring 6 out of 8.

The scores for both market uncertainty and technological uncertainty in this project were identical to those in the Tenormin project. They were scored at 3 out of 8 and 2 out of 6 respectively (see Table 7.8). However, unlike the Tenormin project, the Diprivan project was more research-driven at the later development stage due to the prevalence of drug's technical problems. As a result, the communication between R&D and marketing was not smooth, and a dissatisfaction of marketing with R&D's prolonged time scale was reported. This seems to support the previous finding that the technical difficulties, which

occurred in the Diprivan project as well as in the Augmentin projects, limited effective cooperation between R&D and marketing.

The interface was most effective in the CTD, PSD and OD. The interface in the CSD was effective at the idea stage to provide important commercial input for the direction of the research. However, the corporate management was not highly involved in the major part of the innovation process. This seems to support the previous finding that corporate management involvement in a project is positively related to the development speed of the project.

7.4 THE R&D/MARKETING INTERFACE IN DEVELOPING ZOLADEX

7.4.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Statistics from the World Health Organization (WHO) demonstrate that 19% of the deaths are caused by cancer, the second largest cause of death after cardiovascular disease. Of all cancers, lung cancer is the most common followed by colorectal, breast and prostate cancer.

Zoladex was developed to treat prostate cancer. The average prostate patient is elderly - typical age at diagnosis is about 70. Each year in the U.K., there are 11,000 new cases of prostate cancer, 7,600 death directly caused by prostate cancer.

The most common method of treatment at that time was surgical castration which remains effective in treating the disease. ICI was the first to the prostate market with a effective drug treatment, Zoladex, launched in 1987.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

Although surgical castration was effective, a number of patients felt that a kinder, less invasive alternative would be welcomed. Meanwhile other

companies were also active in this area, daily injections and nasal sprays had been newly developed. Thus, ICI was confronting both non-pharmaceutical and pharmaceutical competitors. According to Mr. Pleuvry, the Marketing Manager for Zoladex,

" In spite of the recent development from the other companies, we felt that we could launch a product more suited to Market needs. For example, nasal sprays, which, whilst an advantage over daily injections, still seemed to leave an aspect of convenience to be desired" (telephone interview, 28th May, 1991).

(2) Technological uncertainty

(i) Cause of disease (CD) and Mode of Action (MA)

The cause of prostate cancer was not very clear. It was found however, the secretion of a chemical substance called gonadotrophin in the pituitary was responsible for the development of hormone-responsive tissues including prostate tumours.

Zoladex has a novel mode of action. It is an LHRH (Luteinising Hormone-Releasing Hormone) agonist. Although natural LHRH has an effect on hormone-responsive tissues including mammary and prostate tumours, the effect is largely limited by the rapid degradation of the peptide and the need for frequent parenteral dosing. Therefore, Zoladex was synthesized with increased stability and potency. When given by the intramuscular or intravenous routes Zoladex is 100 times as potent as LHRH.

(ii) Side Effect (SE)

Zoladex was a relatively safe drug with a low side effect.

(3) Internal Technological and Marketing Strength

(i) Marketing Experience (ME) and Company reputation (CP)

Zoladex was the company's first attempt in the prostate cancer market. Moreover, it was also the first pharmaceutical treatment in this market.

Consequently, the marketing expertise of the company in this area was not well established. Nevertheless, the company had achieved a good reputation because of its earlier success in the breast cancer area.

(ii) Research Experience (RE) and Development Experience (DE)

Although Zoladex was the first drug in the prostate cancer market, the company had successfully developed breast cancer treatment. As a result, the company had possessed some research and development experience.

7.4.2 Strategic Constructs

(1) The Corporate Dimension of the Interface (CSD & CTD)

The corporate management had emphasised the strategic importance of a new anti-cancer drug for the company's long-term growth. However, the target was set for a lung cancer treatment, rather than a prostate cancer treatment, since lung cancer presented the largest category in the cancer market. According to Mr Pleuvry,

"Ideally we would have developed products for lung cancer and colorectal cancer, but at that particular time there were no very obvious leads, whereas by contrast the research lead became available in prostate cancer" (telephone interview, 28, May, 1990).

Because Zoladex was discovered unexpectedly, its potential had not been thoroughly evaluated at the corporate level in either strategic or technical dimensions. Moreover, it was not given high priority and the R&D/marketing interface was minimum. As a result, except for the general understanding that cancer was the company's traditional and strong area, little has been done at this level to assess the balance between the drug's commercial attractiveness and the technical risks it entailed in this particular area - the prostate cancer area.

(3) The Product Strategic Dimension of the Interface (PSD)

Because the discovery of Zoladex by the research was beyond the company's original plan, extensive market assessment was carried out under the collaboration of R&D and marketing. According to Mr Pleuvry,

"We were asked to describe the market characteristics and to state the profile for Zoladex. After extensive marketing research, we decided that the new drug should have an objective response equivalent to castration, would provide a speedy onset, long duration, few side effects, convenient dosage and a good quality of life" (telephone interview, 28, May, 1990).

In addition, R&D and marketing cooperated in developing promotional materials. Because the customers are specialists, an ethical and scientific approach was needed to convince them the efficacy, safety and convenience of the drug in comparison with surgery. All promotional materials have been written, designed, tested, revised and approved for technical accuracy and ethical content. Frequent interaction between marketing, medical development and pharmaceutical departments occurred in accomplishing this task.

(4) The Operational Dimension of the Interface (OD)

Zoladex was launched in a new market. As a result, the marketing department encountered difficulties in acquiring market data. According to Mr. Pleuvry,

"one of the most difficult aspects of the marketing research is trying to predict how much it will be sold, therefore the decision of what size factory to build, especially in a new market where there were few quantitative market data available. We built a computer spreadsheet model which simulated epidemiological and market trends in order to estimate the flow of patients to the new treatment" (telephone interview, 28th May, 1990)

(5) The Product Technical Dimension of the Interface (PTD)

One of the distinguishing features of Zoladex was its new delivery system, and the market implication of this had been identified by the marketing department. However, the technical problems later occurred in developing this system became such a dominant issue in the project team that the market aspect of the drug innovation was largely neglected.

7.4.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

As described in the Diprivan project, the company's structure had been re-organized since 1985. Formal interface mechanisms were established at the corporate level, including Board Meeting, New Product Development Committee (NPDC) and Medical Marketing Strategic Plan (MMSP). They were responsible for interface activities at various innovation stages. However, because Zoladex was discovered unexpectedly at the later exploratory stage, the corporate interface in this project was coordinated through the MMSP only.

(2) The Interface Communication Flows (ICF) and Interface Conflict (IC)

The communication between R&D and marketing was frequent. However, some personnel in the marketing department expressed a dissatisfaction with R&D's prolonged development time scale, which they believed partly resulting from the lack of a sense of urgency.

(3) Relative influence of R&D and Marketing (RIRM)

The Zoladex project was an unexpected result from the corporate plan of developing a lung cancer or a colorectal cancer drug. The development process was similar to a research-driven project, where marketing's job was to find the commercial application for a research-initiated product idea. Nevertheless, the company's R&D and marketing collaborated closely during this process, and none had a dominant influence.

The interface at the later development stage became more R&D dominant, where the main challenge was the realization of the drug's new delivery system¹.

7.4.4 The Innovation Performance

(1) Development Speed (DS)

The development programme took eleven years, which was much longer than the industry's average of eight years.

(2) Innovative Level

Zoladex was a novel agent in a growing class with a new delivery system. Its innovative level was high, and it won the Queens Award for technology achievement in 1990. However, the drug was not perceived by the customers as superior to other treatments.

(3) Sales

In 1991 four years after the launch, it generated merely £50 million in sales. ICI pharmaceutical's marketing people are still working hard to put the figure up.

7.4.5 Summary

In this section, the assessment of the research constructs in relation to the Zoladex case is presented in Tables 7.12 to 7.15. The same measures described in the previous chapters are used. The result will be compared and further analysed in Chapter 9.

(1) Assessment

Table 7.12 Assessment of the Environmental Constructs in the Zoladex Project

Market Uncertainty					Technological Uncertainty				Internal Technological & Marketing Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
1	2	1	1	5	1	2	0	3	0	1	1	1	3

Table 7.13 Assessment of the Strategic Constructs in the R&D/Marketing Interface in the Zoladex Project

CSD & CTD	PSD	OD
minimal interface, and a low priority project.	close and effective, esp. in developing the drug's target profile and in generating promotional materials.	difficulty in obtaining quantitative data.

Table 7.14 Assessment of the Organisational Constructs in the Zoladex Project

ICM	ICF	IC	RIRM
Medical Marketing Strategic Plan (MMSP) at the corporate level, and project team at the lower level.	Frequent within the project team.	Marketing's dissatisfaction with R&D's time scales scales.	Close link in the strategic dimension, but R&D dominated in the technical dimension.

Table 7.15 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, fbn 4th yr
11	Slow	High. Novel agent in growing class, and a new delivery system.	It was not perceived by the customers as superior to the existing treatment.	0.05

(2) Preliminary Discussion

Zoladex was the first effective pharmaceutical treatment in anti-prostate cancer market. Its development involved the discovery of new scientific knowledge in cancer treatment beyond the firm's technological base. Therefore the Zoladex project was a "new-technology and new-market" type of project. The Zoladex case illustrate the fact that, unlike other products, pharmaceutical products cannot be developed to order. It was the prostate cancer area that showed a clear research lead when the company desperately wanted a breakthrough in lung cancer area.

Both the market uncertainty and technological uncertainty in Zoladex development were moderate high, scoring 5 out of 8 and 3 out of 6 respectively. Meanwhile, the company's internal technological and marketing expertise was relatively low, scoring 2 out of 8.

The commercial aspect of the drug (moderate sized market, existence of effective treatment, etc.) could not justify the highly demanding development effort that the company had to make (big investment over a long period of time, overcome difficult technical problems and develop new delivery system, etc.).

The R&D/marketing interface was effective in the PSD, where a close collaboration between R&D and marketing was achieved. However, this delayed effort did not seem to be big enough to compensate the lack of the interface in the CSD and CTD, which had failed to address a crucial balance between the commercial attractiveness and the development risk of the project.

Similar to the Diprivan case, this case shows a connection between the interface effectiveness and the contiguous technical problems occurred during the later

stage of development. Although communication was relatively frequent, Marketing's dissatisfaction with R&D's prolonged time scales was reported. On the whole, the innovation performance of Zoladex was not satisfactory both in terms of the slow development speed and the low sales revenue.

The case study confirms a positive association between the lack of corporate management commitment and low development speed. Moreover, this case strongly supports the previous finding that the R&D/marketing interface is most critical in the corporate dimension at the early planning stage.

Finally, this case has posed a question to be answered - what measures should be taken to deal with those unexpected research findings that are beyond the company's original strategic plan?

7.5 FINAL ANALYSIS

Unlike Glaxo, which is a concentrated ethical pharmaceutical company, or SmithKline Beecham, which is a diversified pharmaceutical company, ICI pharmaceuticals is a major subsidiary of a large chemical company. Cardiovascular is a strong therapeutic area in ICI pharmaceuticals. There were two separate departments within ICI pharmaceuticals R&D: Research Department and Development Department. Similar to R&D, marketing in ICI Pharmaceuticals is also divided into two departments: Product Strategy Department(PSD) and Marketing Operation Department(MOD). Their names reflect precisely their departmental goals and responsibilities: strategic versus operational.

The three drugs studied in this chapter are Tenormin, a hypertension treatment, Diprivan, an intravenous anaesthetic and Zoladex, a prostate cancer treatment. The first two belong to a "related-technology and existing-market" type and the last one belongs to a "new-technology and new-market" type of project. The driving forces of the three projects were not a clear cut of either research or market. The Tenormin project for example was research-driven until the pre-launch stage and became market-driven since then till the post market stage. The Zoladex and Diprivan projects on the other hand, were more market-driven at the early stage, and became more research-driven at the later stage. Their

innovation performance also varied extensively with Tenormin being a great success, Diprivan being a moderate success and Zoladex staying as a question mark.

Similar to the previous chapters, in this section, an effort is made to relate the findings of this chapter to the three research propositions defined in Chapter 3, "The Research Theoretical Framework". These are concerned with the relationships between the strategic constructs, the environmental constructs and the organisational constructs.

The research proposition 1 postulates the existence of the R&D/marketing interface in one or more of the five dimensions described in Box 3. The three case studies have all demonstrated the existence of these interface dimensions. In particular, the interface was present in the CSD, PSD and OD in the Tenormin project, in the CSD, CTD, PSD and OD in the Diprivan project, and in the PSD and OD in the Zoladex project. However, the results reveal that the R&D/marketing interface was still weak in both the CTD and PTD.

Furthermore the research proposition 2 hypothesizes a direct relationship between the environmental constructs and the strategic constructs of the interface. The case studies in this chapter have supported this proposition. In particular, the case evidence suggests that in a "related-technology and existing market" type of project, where the external uncertainty is lower and the internal expertise is higher, the interface is generally more effective in most dimensions. Moreover, the case studies illustrate that unlike other products, pharmaceutical products cannot be developed to order. Therefore, a constant interface in the CSD and CTD is most important to adapting emergent situations in the unpredictable drug research.

In addition, the interface effectiveness in the PTD tends to be negatively affected not only by the new-market and new- or unrelated-technology situation, but also by the contiguous technical problems raised during the development stage. This contiguous technical problem also has a negative effect upon the interface communication effectiveness. This finding revealed a direct relationship between the organizational constructs and the strategic constructs, which is postulated in the research proposition 3. The most commonly occurred interface conflict is marketing's dissatisfaction of R&D's Prolonged time scales.

The case studies' results suggest a link between the strategic constructs of the R&D/marketing interface and the innovation performance. The lack of corporate involvement is also found to be responsible for communication difficulty and slow development speed.

Finally, the case studies reveal that drug differentiation by means of delivery systems, dosage forms and so on often involve technical difficulties, some of them take long time to overcome. Consequently, a successful technical-based drug differentiation becomes an effective entry barrier. The findings indicate that the contiguous technical problems also increase the technological uncertainty of a drug innovation project. They affect the R&D/marketing interface in that the marketing people are uncertain about what messages they should deliver to the customers concerning the product's feature, performance and delivery time.

Note

1. A biodegradable, sustained release formulation which would deliver the drug over a period of at least 28 days.

CHAPTER 8 THE WELLCOME CASE

8.1 INTRODUCTION

Similar to Glaxo, Wellcome is a research-based pharmaceutical company. The company was established in London in 1880 by two American pharmacists, Burroughs and Wellcome. In 1936, Wellcome's ownership was left to The Wellcome trust - a charity body. The trust owned 100% of the company shares. All the incomes they received as a result of this were donated to medical research and the maintenance of research museums. Table 8.1 lists a series of the company's important discoveries in ethical pharmaceuticals.

Table 8.1 Principal Wellcome Discoveries 1968 - 1990

Brand name	Generic name	Type	First launch
Imuran	Azathioprine	Immune suppressant	1963
Septrin	Cotrimoxazole	anti-infective	1968
Zovirax	Aciclovir	Antiviral	1981
Tracrium	Atracrium	muscle relaxant	1982
	besylate		
Retrovir	Zidovudine	Antiviral	1987

In 1985, a new holding company was formed called Wellcome plc. Since then, 25% of the Wellcome Trust's original shares were issued through the International Stock Exchange. Wellcome plc is now the UK-based parent of a group of human health care companies which include The Wellcome Foundation Ltd, Wellcome Diagnostics Ltd and Calmic International Ltd. The company employs 19,000 people world-wide, 18% of whom are engaged in research and development. Its business includes both ethical pharmaceuticals and over-the-counter (OTC) medicine. Table 8.2 shows the financial highlights of the company.

Table 8.2 The Financial Highlights of Wellcome plc

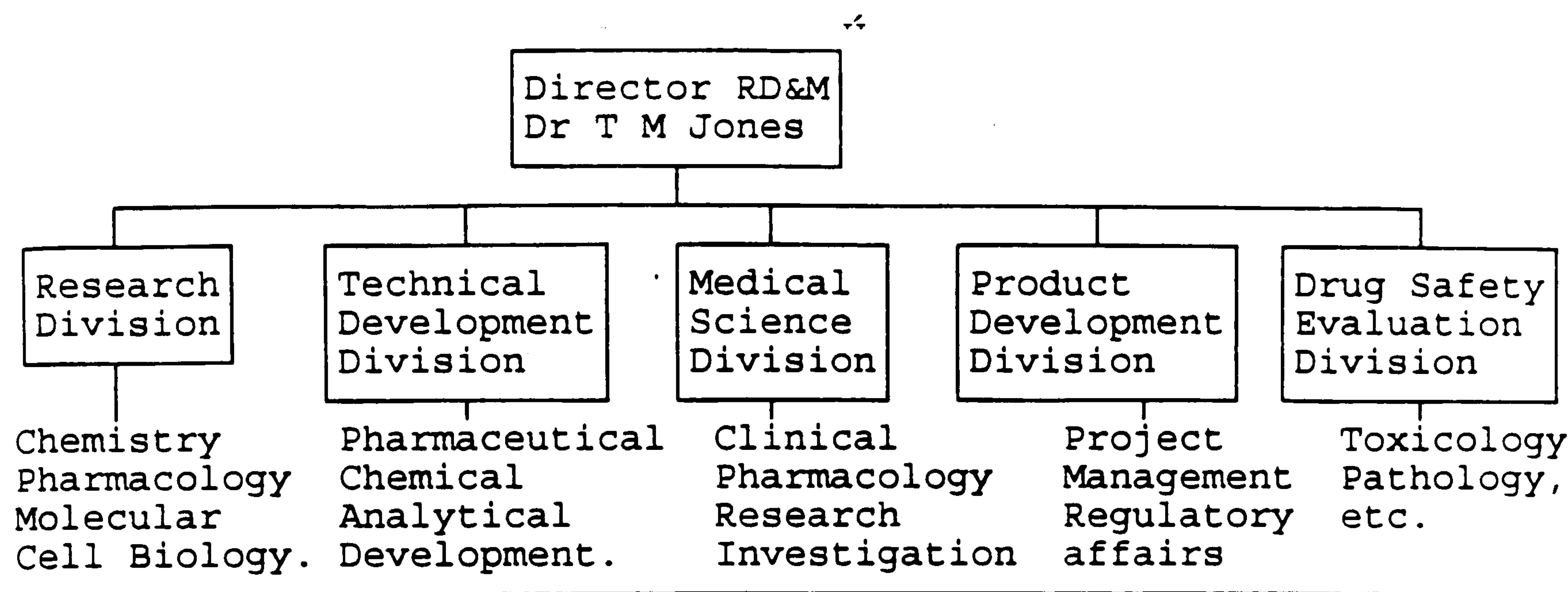
	1991	1990	1989
Turnover	1,606	1,469	1,254
Research and development expenditure	230	221	182
Profit on ordinary activities before taxation	403	315	283

The new holding company, Wellcome plc, has re-organized its structure. The purpose is to build up a more coordinated central system, especially between the UK headquarter and the US subsidiary - Burroughs Wellcome. Mr Heightman, the Strategic Business Manager for Antiviral Products noted that

"Before the re-organization, the company's structure was very fragmented, and our research effort had been spread too thinly. There was some unnecessary duplication of activities as a result of a lack of coordination between us and the highly autonomous US subsidiary" (face-to-face interview, 3rd August, 1991).

Liaison groups are formed at every stage of the development process to coordinate research and development activities between the U.K. headquarter and the U.S. subsidiary. The new structure of the R&D Department in the UK is illustrated in Figure 8.1.

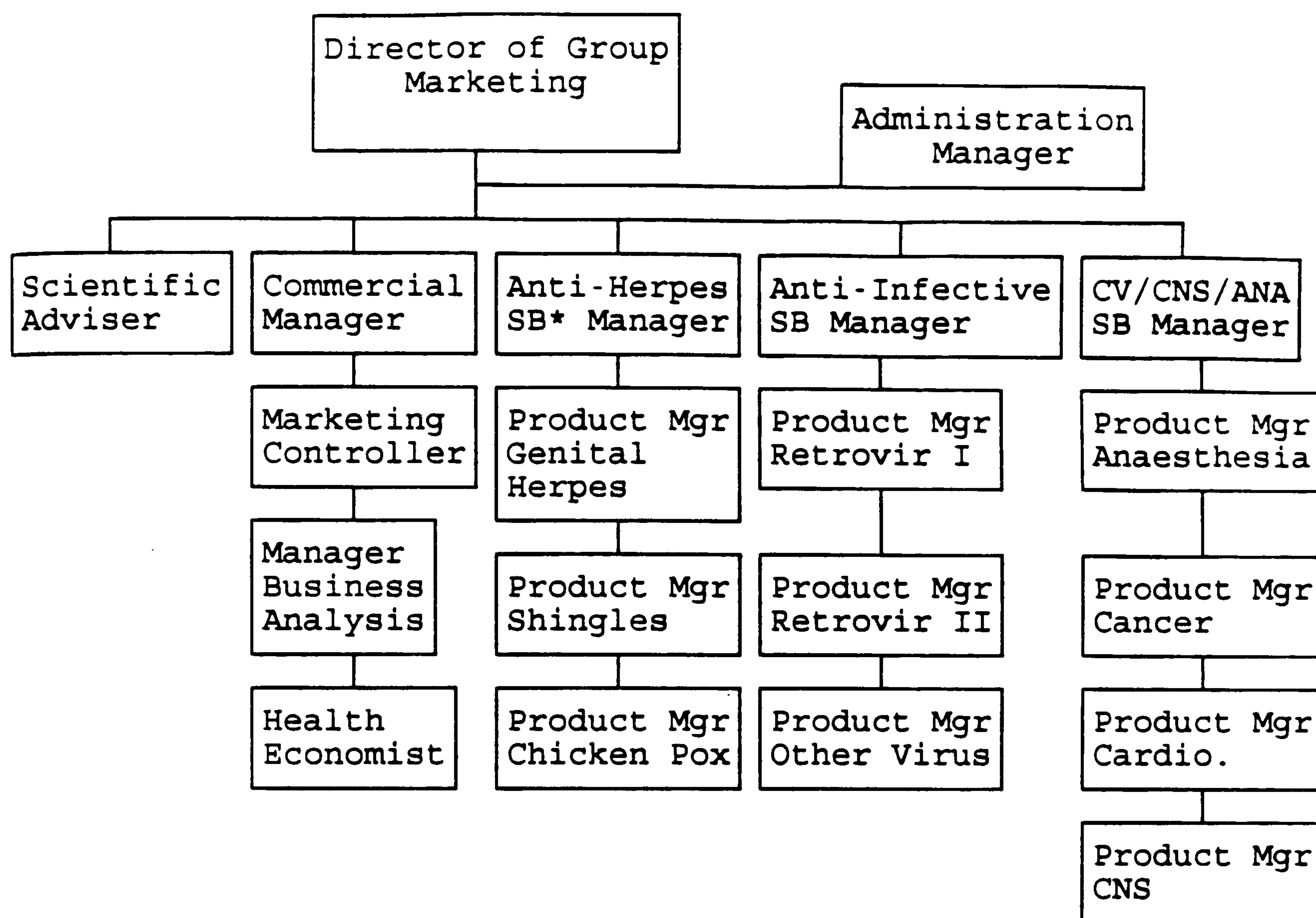
Figure 8.1 Research, Development and Medical (RD&M)¹ Structure (UK)



Source: Wellcome.

Meanwhile the company's Group Marketing Department is organized under three main therapeutic areas, i.e. Anti-Herpes, Anti-Infective and CV/CNS/ANA. This new marketing structure reflects the new holding company's concentration strategy, which focuses on the anti-herpes and anti-AIDS markets (see Figure 8.2).

Figure 8.2 Group Marketing Structure



Wellcome has established its leading position in the antiviral therapeutic area since the early 1980s with its antiherpetic product, Zovirax and AIDS treatment, Retrovir. They together account for 37% of the group total turnover in 1990. Mr Heightman, the Strategic Business Manager for Antiviral Products, emphasized the positive affect of the company's charity background on its research achivement:

"Because the company did not have to endure intense financial pressure from the stock market and the investors, it was able to engage in more fundamental research in some of the most challenging areas such as antiviral research. As a result we gained extensive expertise and a leading position in those areas (face-to-face interview, 3rd August, 1991).

This chapter is intended to study closely the R&D/marketing interface in the development of the three pharmaceutical products: Zovirax, an antiherpetic product, Retrovir, an AIDS treatment and Lamictal, an antiepileptic product. The criteria for selecting product samples have been described in Chapter 2, the research methodology. The R&D/marketing interface during the innovation processes of these three drugs is examined using the three groups of constructs, i.e. environmental, strategic and organizational constructs. Table 8.3 and Table 8.4 show the time scales and descriptions of these three products.

Table 8.3 Product Development Time Scales

Lamictal	Development 1978	Launch 1991	Post market (PED:2006)			
Retrovir	Development 1983	Launch 1987	Post market (PED: 2002)			
Zevirax	Development 1974	Launch 1981	Post market (PED: 1997)			
----- Year						
1965	70	75	80	85	90	95

Table 8.4 Product Descriptions

Drug	Description	Innovative Level
Zovirax	The first selective antiviral drug for herpes treatment. The world's number eighteen best-selling drug in 1990, generating £471M in Sales.	Very high, a novel agent in new class.
Retrovir	The first antiretrovir agent for AIDS and earlier HIV infections. It can delay the development of AIDS, but has high side effects.	Very high, a bio-tech drug. First entrant ina new class.
Lamictal	A new antiepileptic drug, but is only passed as an add-on treatment with existing drugs.	Moderate high, a new agent in established class.

8.2 THE R&D/MARKETING INTERFACE IN DEVELOPING ZOVIRAX

8.2.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Zovirax was the first effective treatment for herpes infections. Thus, it was difficult to evaluate the market size. The company's original market forecast of £15 million was later proved to have significantly underestimated the real market potential. The most recent major indication of Zovirax was launched in 1989 for the treatment of shingles - or herpes zoster infection - which has a large market.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

When Zovirax was first launched in 1981, the need for an anti-herpes treatment was low, owing to the following two factors:

- (a) the infrequent occurrence of herpes infections - an average of twice a year for one doctor - caused diagnosis difficulty;
- (b) the patients' reluctance in seeking treatment for certain herpes infections.

Meanwhile, there was no competition in the market when Zovirax was first launched, and this situation has not changed since then. In spite of several research attempts from competitors to develop new anti-viral drug, the technical barrier was proved too high to overcome. Bristol-Myers Squibb for example developed two anti-herpes compounds, but they were both failed in toxicity test.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

Herpes infections are caused by herpes viruses, they include:

- (a) herpes simplex virus: cold sores, herpes keratitis, genital herpes, and
- (b) varicella-zoster virus: chicken pox, shingles.

There was more scientific knowledge on the herpes simplex viruses than on the varicella-zoster virus, and exactly what triggers an attack of shingles is not known.

Zovirax has an unique and highly selective mode of action. Herpes viruses replicate in the human body by incorporating a substance called deoxyguanosine into the viral DNA chain. Zovirax is an acyclic analogue of deoxyguanosine that prevents such an incorporation.

(ii) Side Effect (SE)

Zovirax has high antiviral activity and low cellular toxicity. It prevents the virus from replicating, but does not destroy the normal cells of the human body. Thus, its side effect is low.

(3) Internal Technological and Marketing Strength

(i) Marketing Expertise (ME) and Company Reputation (CR)

The company's marketing department had no experience in the antiherpes market neither did any other companies. However, the company had a good reputation as an innovator in general.

(ii) Research Experience (RE) and Development Experience (DE)

Wellcome did not have development experience in the antiherpes market. Nevertheless, the research team had several first class scientists who were specialists in the related areas.

8.2.2 Strategic Constructs

(1) Corporate Dimension of the Interface (CSD & CTD)

Antiviral research was one of the most challenging research programmes carried out by the company. These programmes had resulted from the company's then technological policy of pursuing scientific excellence. However, except for this research orientation, the corporate management had little involvement, and there was a lack of R&D/marketing interface in this dimension. According to Ms Leaford, the Marketing Manager for Zovirax from the development stage:

"When Zovirax was first discovered, there was no effective interface at corporate level. As a result, our marketing information was not effectively communicated at that level" (face-to-face interview, 3rd August, 1991).

(2) Product Strategic Dimension of the Interface (PSD)

Marketing's involvement started after the drug was discovered in the research laboratory. The marketing manager was asked to evaluate the drug's market potential. Marketing and R&D also cooperated in deciding pricing strategy near the launch, as Ms Leaford recalled,

"For Zovirax which had no similar drugs to be compared with, we were facing the question of "how much would you charge for an innovative therapy?". We discussed with R&D on other innovative drugs such as Tagamet. A high price premium was finally decided - £25 for genital herpes and £100 for singles" (face-to-face interview, 3rd August, 1991).

The promotion of Zovirax involved both marketing and R&D. The biggest task was to educate both doctors and patients the concept that herpes viruses were

treatable and Zovirax did not have those awful side effects associated with the old treatment.

(3) Operational Dimension of the Interface (OD)

Various market research techniques were applied. However, their effectiveness was limited in a new market situation especially at the early stage. According to Ms Leaford,

"I was asked to evaluate the market potential of the new compound. It was difficult to start with, because there were no similar drugs to compare with in the market. Since the existing data could not provide the required information, the marketing people made direct visits to specialist clinics and studied the therapies of related diseases. Figures from different sources were then added together, which suggested that there was a moderate market, worth £15 million per year. A much bigger market potential was revealed later as the project progressed" (face-to-face interview 3rd August, 1991).

(4) Product Technical Dimension of the Interface (PTD)

The involvement of marketing in this dimension was minimal. The development of the first dosage form - an eye ointment - was solely based on technical considerations. According to Ms Leaford,

"we first launched an eye ointment for herpes simplex infection because it had the same dosage form as an existing old treatment, which provided a basis for comparison" (face-to-face interview, 3rd August, 1991).

The cooperation between marketing and R&D became closer after the launch. Seven different indications have been launched since the drug was first introduced in 1981. They include a series of new launch for genital herpes, intravenous serious herpes infection, cold sores , singles and chicken pox.

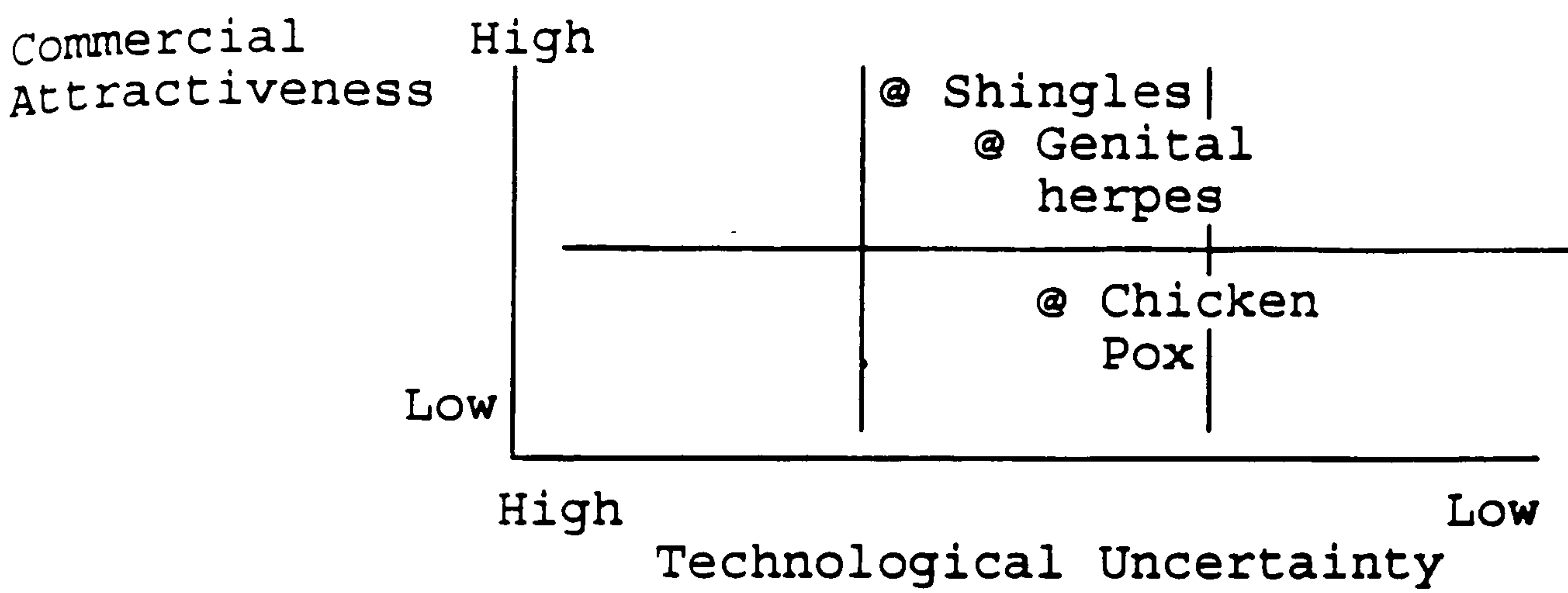
8.2.3 Organizational Constructs

(1) The Interface Coordination Mechanism (ICM)

The coordination mechanism of Wellcome was relatively poor before Zovirax's launch. There were no formal coordination mechanisms at the corporate level. On the other hand, the communication at the lower level was mainly through the project team.

The company's coordination mechanism was largely improved in 1985 when Zovirax was at the post market stage. There was a therapeutic area review meeting every year, where strategic marketing managers and RD&M managers who were in charge of the same therapeutic areas cooperated in deciding the priority of the future drug research in this area. Figure 8.3 is the therapeutic area review in anti-herpes area.

Figure 8.3 Review of the Anti-herpes Therapeutic Area



The different priorities of these diseases in the anti-herpes area have been reflected in the group marketing structure (please refer to Figure 8.1).

(2) The Interface Communication Flows (ICF) and Interface Conflict (IC)

The communication between marketing and R&D was relatively frequent, although it did not happen until the later development stage. Meanwhile, the R&D staff expressed their concerns on the inconsistency of marketing information in different period of time, and therefore their doubt on the credibility of such information. According to Dr Pond, Head of Research in Antiviral area,

"Marketing people has not been very good in generating reliable marketing information we need, both in terms of its accuracy and the specificity. This presents a biggest problem between us as far as I am concerned" (face-to-face interview, 27, March, 1991).

(3) Relative influence of R&D and Marketing (RIRM)

The Zovirax research programme was initiated by the scientists who looked into modified nuclear bases in the hope that the resulting compound would interfere with virus replication.

The interface at the early development stage was to evaluate the market potential for the new compound, and at later development stage was to decide the price strategy and educate customers about the new drug's potency. Although the balance had shifted slightly to marketing near the launch, R&D remained the main drive behind most activities.

The interface was close after the launch and was sustained for eighteen years. This interface was mainly related to the development of the new indications.

8.2.4 The Innovation performance

(1) Development Speed (DS)

Although the time for developing the first indication - eye ointment - only took seven years, the clinical trials for several major indications took much longer to complete. Therefore, the development speed was slow.

(2) The Innovative Level (IL)

Zovirax was the first entrant to a new market and a new class of drug. It was the first biotechnology derived drug, and the innovative level was very high. Furthermore, the drug was perceived by the customers as being unique in meeting their needs.

(3) Sales

Zovirax's market potential was realized relatively late, and its commercial achievement was slowly built up during a period of eleven years. First launched in 1981 with only one indication, it achieved a total sales of £471 million in 1990 with seven indications.

8.2.5 Summary

The same measures which were used in the previous chapters are applied to assess the research constructs in this chapter. The results are shown in Tables 8.5 to 8.8. They will be compared with other case study results in the next chapter, Chapter 9.

(1) Assessment

Table 8.5 Assessment of the Environmental Constructs in the Zovirax Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
1	2	1	0	4	1	2	0	3	0	1	1	0	2

Table 8.6 Assessment of the Strategic Constructs of the R&D/Marketing Interface In the Zovirax Project

CSD & CTD	PSD	OD
The company's technological policy provided a direction for the research. However, the corporate management was not highly involved in the project, and the interface was minimal.	The interface was relatively close in evaluating market potential and deciding pricing and promotion strategies.	In-effective at the early stage.

Table 8.7 Assessment of the Organizational Constructs in the Zovirax Project

ICM	ICF	IC	RIRM
No formal link at top level, and project team at the lower level.	Relatively frequent at later stage.	Lack of marketing credibility perceived by R&D	Mainly research driven during the process. Marketing had more influence after launch.

Table 8.8 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, fbn	
				5th yr	11th yr
12	slow	very high, first entrant in a new class	It was gradually recognized by the customers as being unique in meeting their needs	0.2 (estimate)	0.47

(2) Preliminary Discussion

Zovirax was the first antiviral drug for herpes infection and singles. Its development involved the discovery of new scientific knowledge. Therefore, similar to SmithKline's Tagamet, it was a "new-market and new-technology" type of product.

The market uncertainty in the project was only moderately high, scoring 4 out of 8, due to a lack of competition in the market. Meanwhile, the technological uncertainty was relatively high, which is scored at 4 out of 6. Like most of the "new- or unrelated-technology and new-market" type of projects, the Zovirax project was not supported by extensive marketing and technological expertise (only scored at 2 out of 8).

Similar to the Tagamet project, the R&D/marketing interface presented in two out of five dimensions, namely the PSD and OD. The corporate technological policy was critical in providing the direction for the research. However, the corporate management was not directly involved in the project. The R&D/marketing interface started late. R&D dominated during most of the innovation process, and marketing only began to have a stronger influence after the launch. The communication was relatively frequent, although a lack of marketing credibility as perceived by R&D was reported. On the whole, the drug's innovation performance was satisfactory both in terms of the innovative level and the sales revenue.

Fortunately, unlike Tagamet, Zovirax did not meet strong competition at the post market stage. The drug remained the only product in the anti-herpes market since it was first launched.

Similar to the Tagamet and Imigran projects, the case study has confirmed an association between an R&D dominance, a later starting time of the interface and high technological uncertainty; and an association between a lack of marketing credibility as perceived by R&D and the "new- or unrelated-technology and new-market" type of project. The case evidence also supported the association between a weak corporate management involvement to the project and a low development speed. However, the case results seem to suggest that the development speed is not a major factor for a successful innovation unless the competition in the market was strong, and a strong research base in a difficult research area forms an effective entry barrier for competitors.

8.3 THE R&D/MARKETING INTERFACE IN DEVELOPING RETROVIR

8.3.1 Environmental Constructs

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

Retrovir (also called AZT) is the first treatment for AIDS (Acquired Immunodeficiency Syndrome), which is one of the most recently discovered life threatening diseases. Because doctors had never treated AIDS patients prior to Retrovir's launch, their attitudes and the patients' response to such treatment were poorly understood.

There are approximately 106,000 current AIDS cases and 1.5 million HIV (Human Immunodeficiency Virus) patients, many of whom will develop AIDS. Originally, Retrovir was launched for AIDS patients only. Three years after the launch, in 1990, it was approved for HIV patients. As a result, the market for the drug was significantly enlarged.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

The discovery of Retrovir was highly publicized as a significant scientific breakthrough in AIDS field by both the company and the media. It was therefore well known to the patients and the doctors long before its launch.

After the drug was launched, the market was featured by high demand, highly expensive product (costs £4,500 annually per patient for full doses in 1989) and the product's high side effects. Consequently, the market was highly controversial characterised by high political pressure and deep disappointment from the patients for the drug's high price and side effects.

Being the first drug to treat a serious disease, Retrovir had an unique competitive advantage benefiting from drug legislation. In spite of rivals' attempts in this area (see Table 8.9), the legislation restricted any following entry to an additional medication, which could only be tested and used in conjunction with the approved treatment. As a result, Retrovir became a standard, first-line therapy for AIDS and HIV infection.

Table 8.9 New Competition for AZT

Drugs that block viral gene replication	Manufacturer	Drug trial status
DDI	Bristol-Meyers	Phase II trials
DDC	Hoffmann-LaRoche	In Phase II trials
D4T	Bristol-Meyers	In Phase I trials
Carbovir	Glaxo	Preclinical

Source: Business Week, September 11, 1989.

(2) Technological Uncertainty

(i) Cause of Disease (CD) and Mode of Action (MA)

The cause of AIDS was relatively clear, it was identified to be an infection with a retrovirus known as human immunodeficiency virus (HIV). This virus infects and destroys specialised cells of the immune system, leading to a profound depression of natural immunity.

Retrovir is a biotechnological product, it is an analogue of naturally occurring thymidine. When HIV replication takes place in the presence of Retrovir, Retrovir is mistaken for thymidine. As Retrovir does not contain the key

element of thymidine, the proviral DNA chain is terminated and viral replication is therefore halted.

(ii) Side Effect (SE)

Retrovir has relatively high toxicity. It can cause serious side effects, including severe anaemia, myositis, and seizures.

Since Retrovir is toxic, much effort has been focused on developing treatment regimens which are tolerated better by patients. This has meant lowering doses of Retrovir and alternating it with other nucleotide analogues, such as dideoxycytidine (ddC). Because of Retrovir's toxicity, only 60% of patients are now receiving the drug.

(3) Internal Technological and Marketing Strength

(i) Marketing Experience (ME) and Company Reputation (CR)

The company had no previous experience in the AIDS market. Nevertheless, the company had gained good reputation in the related area with its earlier success - Zovirax.

(ii) Research Experience (RE) and Development Experience (DE)

Although AIDS research was new to Wellcome, it belonged to the antiviral research area to which the company had been deeply committed since the early 1980s. Thus, the research of Retrovir had a close link to the company's earlier antiviral drug, Zovirax.

8.3.2 Strategic Constructs

(1) Strategic Dimension of the Interface (CSD & PSD)

Retrovir project was initiated by the company's American subsidiary, Burroughs-Wellcome. It became a major corporate concern after the drug's activity against AIDS was discovered in 1985. The chairman of Wellcome was appointed as the leader of this programme and most of the strategic decisions were made at the corporate level.

However, there was a lack of appropriate interface activities between R&D and marketing in this dimension. For instance, no sufficient effort was made to inform and to educate the customers about the drug's high side effects and no proper promotion strategy was developed. Instead, with the high demand in the market, the company assumed a favourable attitude from customers toward the drug. According to Ms Leaford, the Marketing Manager for Antiviral Products,

"Retrovir was launched only two years after its activity was discovered, whereas the average development time for a drug is eight years. As a result, there was not enough time for an adequate market research, a pre-launch programme, or an external consultant, which are usually carried by Wellcome for most of its new products" (face-to-face interview, 3rd August, 1991).

(2) Corporate Technical Dimension of the Interface (CTD)

The Retrovir project was a direct result of the company's technological policy of pursuing scientific excellence. A press comment noted that

"It wasn't just an accident or luck that Burroughs-Wellcome got there first. The company specialises in obscure diseases and disdains common ones, emphasising arcane research so strongly that employees proudly call it 'Wellcome University'. That approach helped enormously in the search for AZT" (Fortune, Nov. 5, 1990).

From a research viewpoint, the Retrovir project appeared to be a perfect follow-up after the company's anti-herpes product, Zovirax. However, very little had been done to assess the market consequence of such a project. As a result, The company found itself ill prepared for the huge emotions and politics surrounding AIDS.

8.3.3 Organizational Constructs

(1) Interface Coordination Mechanism (ICM)

There was no formal coordination mechanism at the corporate level, and the interface between R&D and marketing was present only within the American subsidiary at project level before the pre-launch stage. The interface has become more effective and more frequent since then because of the strong commitment of the corporate management to the project.

(2) The Interface Communication Flow (ICF) and Interface Conflict (IC)

As noted earlier, communication within the organization on the Retrovir project was effective and smooth, resulting from the strong commitment of the corporate management. According to Ms. Leaford,

"The top management commitment certainly made the communication between different parts of the organization much more smooth and quicker. However, this situation also meant some distraction on other projects and on some normal business activities" (face-to-face interview, 3rd August, 1991).

(3) Relative Influence of R&D and Marketing (RIRM)

Retrovir was originally synthesized in 1964 at an attempt to produce an effective anti-cancer drug. The research was stopped due to unsatisfactory results. In 1983, two years after scientists identified the cause of AIDS, Burroughs Wellcome, which enjoyed high autonomy at the time, initiated the project of studying Retrovir as a promising AIDS treatment. After the confirmation of anti-AIDS activity of the compound in 1985, the project was given top priority by the company.

During the short development time of three years, the R&D/marketing interface was rather brief and superficial. It was driven by urgent political and production matters which occurred during the development.

8.3.4 The Innovation Performance

(1) Development Speed (DS)

The development time of four years for Retrovir was considerably shorter than the industry average of eight years. However, some clinical and marketing activities were not adequately undertaken due to shortage of time, which caused problems after the product was launched.

(2) Innovative Level (IL)

Retrovir was a highly innovative biotechnological product. It is the first entrant in a new class, and remains the only treatment for AIDs and HIV infection up to now. However, its real effect was still the centre of debate.

(3) Sales

As indicated earlier, Retrovir is a highly expensive drug, costing £6,500 per annum for each patient. This high price contributed significantly to the £400 million in sales a year.

8.3.5 Summary

As in the previous chapters, qualitative measures are used for assessing the environmental, strategic and organisational constructs in this chapter. The results are shown in Tables 8.10 to 8.13. They will be compared with other drug innovation cases in the cross-case analysis presented in Chapter 9.

(1) Assessment

Table 8.10 Assessment of the Environmental Constructs in the Retrovir Project

Market Uncertainty					Technological Uncertainty				Internal Marketing & Technological Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
0	2	1	1	4	0	2	2	4	0	1	1	1	3

Table 8.11 Assessment of the Strategic Constructs of the R&D/Marketing Interface in the Retrovir Project

CSD & PSD	CTD
Corporate management was committed to this project. However, due to shortage of time, the interface was weak.	The project was strongly influenced by the corporate technological policy. However the interface was weak.

Table 8.12 Assessment of the Organizational Constructs in the Retrovir Project

ICM	ICF	IC	RIRM
no formal link at top level, but very strong top management commitment; a project team at lower level.	highly effective and frequent.	no major conflict reported.	mainly corporate management driven with a strong time orientation.

Table 8.13 Assessment of the Innovation Performance

DT (yrs)	DS	Innovative Level	Superiority	Sales, £bn 1st yr	5th yr
4	very fast	Very high, first entrant in a new class	unique, but controversial	0.2	0.4

(2) Preliminary Discussion

Similar to the Tagamet and Zovirax projects, the Retrovir project was a "new-market and new-technology" type of project. Its technological uncertainty was high, scoring 4 out of 6, and its market uncertainty was moderately high, scoring 4 out of 8. Moreover, these uncertainties were not adequately dealt with due to the shortened development time. However, unlike the other two same

type of projects mentioned above, because the company had acquired some scientific knowledge and expertise in antiviral field, the Retrovir project benefited from a slightly higher internal expertise, which is scored at 3 out of 8.

The R&D/marketing interface presented in the CSD, PSD and OD. However, because of the extremely short development time, the interface was brief and superficial, which was mainly for drug registration purposes rather than for strategic or technical purposes. Nevertheless, the cross-functional communication was highly effective and frequent, which was largely attributable to top management's commitment to the project. In addition, the unusually fast drug approval from the regulatory authorities contributed to the rapid development programme. The drug had achieved a high sales revenue during the first two years of its launch.

This case tends to suggest that an effective R&D/marketing interface is important in the "new-market and new-technology" type of project. Since the reduction of the high development risk requires extensive market research over a certain period of time, the advantage gained from a faster development should be weighed against the higher development risk stemming from such a move. Nonetheless, the case study has revealed the advantages of being fast or being first to market. These include:

- (a) a strong corporate image and a leading position on the experience curve that characterizes the new technology, in this case, the biotechnology in antiviral area;
- (b) an initial differentiation for the new drug, thus a high price policy; and
- (c) a first-line treatment, which is an effective barrier to entry.

8.4 THE R&D/MARKETING INTERFACE IN DEVELOPING LAMICTAL

8.4.1 Environmental Uncertainty

(1) Market Uncertainty

(i) Market Size (MS) and Market Newness (MN)

When Lamictal was launched in 1991, the epilepsy therapeutic market was well established with a moderate size of approximately £560 million a year worldwide. In addition, because Lamictal was only passed by the regulatory authority as an add-on treatment to the existing drugs, its usage was largely restricted.

(ii) Customer Need Awareness (CNA) and Market Competitiveness (MC)

There had already been several effective antiepileptic drugs in the market before Lamictal was launched, including Warner Lenbert's Phenytoin, Cibe-Geigy's Carbamazepine, and Merow Mon's Sabril, newly launched in 1990. Lamictal was developed by Wellcome at the attempt to offer the patients the benefit of a low side effect treatment. However, big educational effort was needed to implement this differentiation strategy. according to Mr Milton, the Marketing Manager for Lamictal,

"Doctors who had gained their experience in treating epilepsy patients with existing drugs were convinced that side effects such as sedation and depression of the central nervous system function, were not separatable with drugs efficacy" (face-to-face interview, 3rd August, 1991).

(2) Technological Uncertainty

(i) Cause of Disease (CD), Mode of Action (MA) and Side Effect (SE)

The cause of epilepsy is partly known. It is related to the balance between two chemical substances - glutamate and GA (gamma-aminobutyric). The level of

glutamate and the level of GA are intimately related. An excess of glutamate relative to GA is widely believed to be responsible for epileptic seizures.

Before Lamictal, most antiepileptic drugs were designed to increase the overall level of GA. Such drugs usually provide adequate seizure control but they have high incidence of side-effects. Wellcome scientists believed that those side effects were not inevitable. Rather, they were related to the increased level of GA in those drugs, which reduced the overall responsiveness of the central nerves system (CNS).

Lamictal was therefore developed to overcome such shortcomings of the existing drugs by preventing excessive release of glutamate. Because the drug does not depress the normal CNS function, it has low side effect.

(3) Internal Technological and Marketing Strength

(i) Marketing Experience (ME) and Company Reputation (CR)

Lamictal was Wellcome's first attempt in the epilepsy market. Thus, the company had no previous experience and was not well-known to the customers.

(ii) Research Experience (RE) and Development Experience (DE)

The therapeutic use of anti-folate compounds, which were also used in Lamictal, was a field in which the Wellcome Foundation already had considerable research expertise. However, as indicated above, the company had never developed drugs for treating epilepsy. This lack of experience in the project team in handling the clinical trials programme and the registration affairs was partly responsible for the unsatisfactory result of this project. According to Mr Heightman, the Strategic Business Manager of the company,

"I think the handling of the clinical trial programme for Lamictal was very poor. For one thing, it failed to generate the right data for the registration purpose. On the whole, the project was not a success. However, it was not a typical example of what we are doing in this company" (face-to-face interview, 3rd August, 1991).

Finally, Lamictal was only passed as an add-on treatment in addition to the existing drugs, which meant that the new drug's main advantage of having lower side effect was largely diminished. Mr Milton defended this result,

"clinical trials on epilepsy are highly ethical as on any other life threatening diseases, The regulation requires that the quality of the treatment on any patient must not be reduced as a result of the clinical trials. Because the existing antiepileptic drugs are efficacious, Lamictal must be tested in addition to an existing drug" (face-to-face interview, 3rd August, 1991).

8.4.2 Strategic Constructs

(1) Corporate Dimension of the Interface (CSD & CTD)

Lamictal was not a high priority project of the company. As a result, the corporate management had little involvement in the project, and most of the R&D/marketing interface activities were carried out within the project team.

(2) Product Strategic Dimension of the Interface (PSD)

R&D and marketing cooperated at this level, attempting to provide the right direction for the clinical trials. Both the scientific property of Lamictal and the existing market conditions were considered. Mr Milton recalled

"having studied the market condition, we decided that clinical data should be collected mainly to show Lamictal's safety and tolerability rather than its efficacy. Because the existing drugs were already efficacious but had high side effect" (personal interview, 3, August, 1991)

Meanwhile, the promotion strategy was designed to educate the customers the safety profile of the drug. According to Mr Milton

"We carried out early market research four years before the launch, which was important for the promotion strategy. The message to the market was that because of Lamictal's novel mode of action, it did not have those side effect which were associated with the existing drugs. Education was an important part of this strategy" (personal interview, 3, August, 1991).

In addition, R&D and marketing also cooperated in identifying new markets for the drug. Although Lamictal was originally tested in adult patients, the marketing people later realized that a low side effect antiepileptic drug was most appealing to children who presented a big potential market.

(3) Operational Dimension of the Interface (OD)

Epilepsy was a well established market. Thus, quantitative and qualitative marketing research was carried out to provide important input for both strategic and technical purposes.

(4) Product Technical Dimension of the Interface

The strategic decision of penetrating the children's market confronted technical problems regarding the drug's stability in water. As a result, Syrup - the ideal paediatric dosage form - could not be developed. Alternatively, under the close cooperation between the RD&M department and the Marketing department, a special dissoluble tablet was developed.

8.4.3 Organizational Constructs

(1) The Interface Coordination mechanism (ICM)

There was neither a formal coordination mechanism at the corporate level nor an informal involvement from the corporate management. As a result, the communication at this level was minimal. According to Mr Milton,

"We (R&D and marketing) were very close within the project team, as I have explained earlier, we did lots of things together, but we were not very much involved as far as the corporate decision-making was concerned" (face-to-face interview, 3rd August, 1991)

(2) The Interface Communication (ICF) and Interface Conflict (IC)

The communication between R&D and marketing was frequent and relatively smooth within the project team, and no major conflict occurred. However, there was a communication barrier between the project team and the corporate management.

(3) Relative influence of R&D and Marketing

Lamictal was initiated by the scientists in the Research Laboratories. The original research goal was to improve the existing therapy by reducing the potential of fatal abnormality. The drug's new mode of action was discovered later in research which enhanced its properties.

Marketing became involved after Lamictal was proceeded to the development stage. The interface at the early development stage was the evaluation of the commercial viability of the new idea proposed by the research people, and R&D was the prime drive behind marketing's activity. Marketing's influence became stronger at the pre-launch stage, where the interface focused on product differentiation and promotion.

8.4.4 The Innovation performance

(1) Development Speed

The development speed of Lamictal was very slow. The process took thirteen years.

(2) Innovative Level (IL)

Lamictal had a moderately high innovative level. It was an new agent in an established class. However, the new drug's superiority in meeting customers' needs was not recognized, and it was only used as an add-on therapy.

(3) Sales

Lamictal's UK sales in the first six months after launch was only £3 million, and was slightly increased to £10 million in the second year. It was more expensive, costing £2 per day, compared with £0.2 per day for the existing drugs.

8.4.5 Summary

Similar to previous chapters, the research constructs in this chapter are assessed by using qualitative measures described in Chapter 3, the theoretical framework. Following a brief preliminary discussion at the end of this chapter, the results which are illustrated in Tables 8.14 to 8.17 will be further analysed in the cross-case analysis in next chapter.

Table 8.14 Assessment of the Environmental Constructs in the Lamictal Project

Market Uncertainty					Technological Uncertainty				Internal Technological & Marketing Expertise				
MS	MN	CNA	MC	Score	CD	MA	SE	Score	ME	CR	RE	DE	Score
1	0	2	2	5	1	2	0	3	0	0	1	0	1

Table 8.15 Assessment of the Strategic Constructs of the R&D/Marketing Interface In the Lamictal Project

CSD & CTD	PSD	OD	PTD
minimal and no top management involvement.	close in market evaluation and promotion.	early and extensive market research for both strategic and technical purposes.	close

Table 8.16 Assessment of the Organizational Constructs in the Lamictal Project

ICM	ICF	IC	RIRM
no formal link at top level, a low priority project; a project team at lower level.	effective within project team, but communication barrier at higher level.	no major conflict occurred.	Research driven at early stage, but a close link at pre-launch stage.

Table 8.17 Assessment of the Innovation Performance

DT	DS	Innovative Level	Superiority	Sales, fbn	
(yrs)				6th month	2nd yr
13	very slow	moderate high. a new agent in an established class.	its main advantage of having a lower effect was undermined by its restricted usage.	0.003	0.01

(2) Preliminary Discussion

Lamictal was not first to the market. There were a large number of competing drugs in this moderate-sized market. Thus the entry barrier for the company was very high, stemming from customers' loyalty to existing treatments and stringent drug regulation on clinical testing for certain diseases. The Lamictal project belonged to an "unrelated-technology and new-market" type of project.

The market uncertainty in this project was therefore very high, scoring 5 out of 8. On the other hand, although the company had some research experience, both of its marketing expertise and development expertise were lacking in this field. This is reflected by its low internal expertise, scoring 1 out of 8. The drug had moderate technological uncertainty, scoring 3 out of 6. However, because the drug could not be used as a first-line treatment, its major technical advantage of having low side effects was diminished.

Similar to SmithKline Beecham's Eminase project, the R&D/marketing interface was only present in the PSD, OD and PTD with a notable absence of a corporate interface. As a result, some critical activities which ought to be done at this level such as a preliminary market assessment and the provision of a high level strategic input into the clinical trial programme were very much lacking.

Consequently, although considerable effort had been made at the early stage within the project team to decide the product differentiation and promotion strategies, the premise of their implementation - the drug being a first-line treatment - was non-existent. This result provides a support to the findings in the previous chapters that a poor innovation performance is associated with a lack of the R&D/marketing interface in the corporate dimension. Such an interface is especially important in a "new- or unrelated-technology and new-market" type of project. The case evidence has also confirmed the relationship between the development speed of a project and the degree of the corporate management's commitment to the project.

8.5 FINAL ANALYSIS

Similar to Glaxo, Wellcome is a research-based pharmaceutical company. The company was owned by a charity body until 1985. In 1985 a new holding company Wellcome plc. was formed, and 25% of the Wellcome Trust's original shares were issued through the International Stock Exchange. Since then the company's organizational structure went through a series of major changes, and its ethical pharmaceutical division was narrowed to three major therapeutic areas: anti-herpes, anti-infective (anti-virus), and CNS. Wellcome had a leading

position in the antiviral therapeutic area. Its antiviral products Retrovir and Zovirax accounted for 37% of the group total turnover in 1990.

The three drug projects studied in this chapter are the Zovirax, Retrovir and Lamictal projects. They belonged to a "new-technology and new-market" type and an "unrelated-technology and new-market" type of project respectively. Meanwhile their driving forces varied, and included both research and corporate management. The case studies in this chapter have sustained the findings from the previous chapters on the relationship between

- (a) the role of the R&D/marketing interface and the changing market and technological environment;
- (b) the effectiveness of the interface and the innovation performance.

In this section, the findings of the three case studies are related to the research propositions defined in the theoretical framework, in terms of the relationship between the strategic constructs, the environmental constructs and the organisational constructs.

The research proposition 1 postulates the existence of the R&D/marketing interface in one or more of the five dimensions listed in Box 3. Clearly, all the three case studies have demonstrated the existence of these dimensions. For instance the interface was present in the PSD and OD in the Zovirax project, in the CSD, PSD and OD in the Retrovir project and in the PSD, OD and PTD in the Lamictal project. Again the case studies reveal a weak R&D/marketing interface in the CTD and PTD.

The research proposition 2 hypothesizes a direct relationship between the environmental constructs and the strategic constructs, to which the case studies have also provided positive evidence. For instance, the case studies have supported findings from the previous chapters, including a positive relationship between a later starting time of the interface and a high technological uncertainty as well as the important role of the interface in the CTD in a "new- or unrelated-technology and new-market" type of project.

The research proposition 3 postulates a direct relationship between the environmental constructs and the organizational constructs, which the case studies' results have also supported. The results have sustained the findings from the previous chapters that the relative influence of R&D and marketing, which is reflected by the driving force of the innovation, is related to both external uncertainty and internal strength. Specifically, an innovation project which involves high technological uncertainty and at the same time has low marketing expertise is likely to be research-driven. In addition, the results have supported the previous findings that the lack of marketing credibility as perceived by R&D is associated with a "new- or unrelated-technology and new-market" type of project.

Next, the results have sustained the previous findings that the interface communication flows and the development speed are largely influenced by the corporate management's commitment to the project. However, the results reveal that comparing with development speed, a company's strong research expertise is sometimes a more important competitive advantage which pre-empted the possibility of any competitive entry, as the Zovirax Case illustrated. Meanwhile, a company's technological policy has a profound influence upon its research output, in terms of incremental or radical. On the other hand, although fast development speed does bring many advantages to the company such as a strong corporate image and a leading market position of being the first-line treatment, it has to be balanced with development risk. This risk is negatively associated with the development time, and the reduction of such risk requires effective interface between R&D and marketing.

Moreover, the case study results reveal that a clinical trials programme including clinical testing and registration affairs is an strategic issue as well as an operational issue, and the R&D/marketing interface is important during this process. However, the strategic aspect of this programme has been largely ignored, as the case Lamictal indicated.

The total of twelve drug innovation cases within four pharmaceutical companies have been presented in Chapters 5 to 8. In the next chapter, the Cross-Case Analysis, information from the within-case analyses is further analyzed and conclusions are provided.

Note

1. In Wellcome, the R&D department is named RD&M, which reflects the company's recognition of the important and unique role of doctors being both scientists and marketers who know the market as well as the drug.

CHAPTER 9

CROSS-CASE ANALYSIS, EMPIRICAL FINDINGS AND MANAGERIAL IMPLICATIONS

9.1 INTRODUCTION

In the previous chapters, four within-case analyses were carried out. Each involved detailed case study write-ups of three specific drug innovation projects of one pharmaceutical firm. The within-case analysis was organized under the three groups of constructs, i.e. the environmental constructs, the organizational constructs and the strategic constructs, which have been identified in Chapter 3, "The Research Theoretical Framework". Guided by the research propositions developed in the framework, the relationships between these constructs have been tentatively suggested in the preliminary discussion at the end of each within-case analysis. In this chapter, results from the four within-case studies are compared and further analyzed.

In 9.2 the limitations of the existing studies which have inspired the current research are briefly summarized before analysing the empirical findings in relation to each of the three research questions. In 9.3 a general discussion on the theoretical and managerial implications of the empirical findings is provided, where several unexpected findings are emphasized. Finally in 9.4 the important research findings and their implications for the managers and the future research are briefly summarized.

9.2 EMPIRICAL FINDINGS OF THE CURRENT RESEARCH IN RELATION TO THE RESEARCH QUESTIONS AND PROPOSITIONS

This section is organized under the three research questions defined in the framework. The extent to which the research questions are addressed and the extent to which the research propositions are confirmed and further elaborated by the case studies' results are carefully examined.

9.2.1 The Role of the R&D/Marketing Interface in Product Innovation

In the literature, although the importance of the R&D/marketing interface in product innovation has been increasingly emphasized, the exact areas in which the interface has been present and effective remain ambiguous. Furthermore, most existing studies on the R&D/marketing interface focused only at one level of the interface problems, either relating to the efficacy of structural linkages for achieving better corporate performance or concerning the effectiveness of functional integration for successful product innovation. A understanding of the critical link between the interface at corporate level and that at project level was thus very much lacking. Therefore, one of the main objectives of the current research is to define more precisely the areas of the R&D/marketing interface in product innovation at both corporate level and project level through empirical investigation. These areas form an integral part of the strategic role of the interface. The first question being raised in the research is

Q1: What is the role of the R&D/marketing interface in product innovation?

In the research theoretical framework, five dimensions of the R&D/marketing interface are defined as the strategic constructs. They are: the Corporate Strategic Dimension (CSD), the Corporate Technical Dimension (CTD), the Product Strategic Dimension (PSD), the Product Technical Dimension (PTD) and the Operational Dimension (OD). The above question is addressed by Proposition P1.

P1: the R&D/marketing interface plays an important role in one or more of the five dimensions, during one or more of the five stages of product innovation.

The results of the four within-case analyses regarding the interface role and its variation are summarized in Table 9.1.

Table 9.1 The Role Variation of the R&D/Marketing Interface in Drug Innovation

----- Presence and Effectiveness -----					
Low		-----			High

Project	not present	a weak presence	effective	highly effective	

Serevent		CTD	CSD	PSD, PTD, OD	
Augmentin		PTD	PSD	CSD, CTD, OD	
Diprivan		CSD, PTD		CTD, PSD, OD	
Zantac	CTD	CSD	PTD	PSD, OD	
Imigran	PTD	OD	CTD	CSD, PSD	
Tenormin	CTD	PTD	CSD, OD	PSD	
Tagamet	CSD, CTD	PTD	PSD, OD		
Lamictal	CSD, CTD	PTD	PSD, OD		
Zovirax	PTD	CSD, CTD, OD	PSD		
Zoladex	CSD, CTD, PTD	OD	PSD		
Retrovir	PTD, OD	CSD, CTD, PSD			
Eminase	CSD, CTD	PSD, PTD, OD			

The projects in Table 9.1 are ordered according to the number of highly effective dimensions presented in a project.

Clearly, the empirical results in Table 9.1 have supported the research proposition. The R&D/marketing interface was present in at least two dimensions, i.e. the Operational Dimension and the Product Strategic Dimension (in the Zoladex project) and at most all five dimensions (in the Serevent, Augmentin and Diprivan projects). Therefore the areas of the R&D/marketing interface in product innovation can be more precisely defined as covering the five dimensions, i.e. the corporate strategic dimension, the corporate technical dimension, the product strategic dimension, the product technical dimension and the operational dimension.

Moreover, the responsibilities of the R&D/marketing interface in these five dimensions and their relationships are identified. In the corporate strategic dimension, the R&D/marketing interface provides critical input to the formulation of business strategy with respect to the identification of market opportunities over the firm's strategic time horizon. Table 9.1 reveals that four

out of the twelve innovation projects had a highly effective or effective R&D/marketing interface in this dimension.

Meanwhile, in the corporate technical dimension, the interface provides critical input for the formulation of firm's technology strategies with respect to the evaluation of external technological trends and internal technological competence. Table 9.1 illustrates that only three out of the twelve innovation projects had a highly effective or effective R&D/marketing interface in this dimension. This indicates that the R&D/marketing interface at corporate level is still lacking in both strategic and technical dimension in many innovation projects.

In addition, in the product strategic dimension, the R&D/marketing interface is responsible for deciding various strategies for a specific product. The empirical findings in Table 9.1 show that ten out of the twelve innovation projects achieved a highly effective or effective R&D/marketing interface in the strategic dimension. This finding is in line with the preliminary findings of the pilot study regarding the increased importance of strategic marketing in the organization. However this finding implies that the strategic marketing role is still limited at project level.

Meanwhile, in the technical dimension, which is responsible for maximizing the design characteristics of the product, only two out of the twelve innovation projects achieved a highly effective or effective R&D/marketing interface in the technical dimension. This finding confirms the existing finding in the literature (Bonnet, 1986) that there is a weak product design link in the R&D/marketing interface.

In the operational dimension, the R&D/marketing interface is involved in the application of market research techniques to provide required market information for either strategic or technical purposes. The findings in Table 1 illustrate that seven out of the twelve innovation projects had a highly effective or effective R&D/marketing interface in this dimension.

9.2.2 The Environmental Influence upon the R&D/Marketing Interface

In the Innovation literature, effort has been made to link the R&D/marketing interface to the market and technological environment of the firm. Souder (1989) for example suggests that the interface pattern may be different for firms facing different customer and R&D sophistication. However, although existing studies have provided positive evidence on the environment-R&D/marketing interface linkage, only limited interface and environmental variables were tested. Therefore, in the current research, the environmental influence upon the R&D/marketing interface is thoroughly investigated by examining the relationships between the five interface dimensions and the environmental constructs, i.e. the market uncertainty, technological uncertainty and internal strength, defined in the framework.

In the framework six major types of innovation project are categorized (please refer to Figure 1.1, p.22). These are the "related-technology and existing-market" type, the "related-technology but new-market" type, the "unrelated-technology but existing-market" type, the "unrelated-technology and new-market" type, the "new-technology but existing-market" type and the "unrelated-technology but existing-market" type of project. They differ from each other in terms of their closeness to the existing market and technology.

The within-case analyses reveal that the twelve innovation projects studied belong to three different types of project. These are the "related-technology and existing-market" type (Cell A), the "unrelated-technology and new-market" type (Cell D) and the "new-technology and new-market" type (Cell F) of project. The other three types of project (i.e. Cell B, C and E) defined in the theoretical framework are not found in the twelve innovation cases. Nonetheless, it is not a fundamental requirement of the research design to include all six types of project.

Firstly, the type of project was introduced into the research because it reflects (rather than replaces) the environmental uncertainty involved in a project in a more systematic way. Thus, as described in Chapter 2, "it is helpful when comparisons are made and characteristics are discussed between different drug innovation cases in the cross-case analysis. As a result, the question Q2 "do the

changing technological and market conditions affect the interface role and how?", can be more easily and effectively answered via the following question

Q2: Do the types of the projects affect the interface role and how?"

However, the type of project is not considered as a main criterion for the selection of the products (please refer to Table 2.3, p.45). This is because the primary research objective is to study the relationship between the environmental uncertainty and the R&D/marketing interface, rather than that between the type of project and the interface. This emphasis is indicated by the research proposition stated below, which is designed to address the research question Q2.

P2: The changing technological and market conditions that are specified in the environmental constructs affect the interface role both in terms of the interface needs and the interfacing difficulties.

As a result, the inclusion of all six types of project is not fundamental to the research design for the study of the relationship between the environmental uncertainty and the R&D/marketing interface. Nevertheless, an attempt is made to understand the reasons for the absence of some of the project types. For instance, the "unrelated-technology and existing-market" type (Cell C) is not found in the current research, because all the firms studied belong to the leading innovators. Thus, they have established a strong technological base in their major market. This tends to result in a reluctance to adopt unrelated technology (already used by other companies) to their existing market. For example, Dr Sime, the Senior Vice President of SmithKline Beecham stated that,

"Beecham has established a strong base in penicillin research since the 1960s. As a result, we have successfully launched a series of penicillin products in the antibiotic market. Meanwhile, more and more non-penicillin based antibiotics have emerged in the market. We are at the moment evaluating the viability of such approach to our antibiotic research. However, this seems to be rather remote since we have established a strong base in penicillin research area and intend to reinforce it" (Face-to-face interview, 18th May, 1991).

In addition, the absence of Cell E, the "new-technology and existing-market" type, can be explained also. The market effect of this type of project is noted in both innovation literature and marketing literature (Dussauge, et al., 1992; Levitt, 1960). Specifically, since a radical innovation or a highly innovative activity results in a new market, market broadening or market restructuring, a project that entailed a new technology but does not affect the nature of the market is rare. In Table 9.2 below, the twelve drug innovation projects studied in the within-case analyses are summarized according to their types.

Table 9.2 Types of the Drug Innovation Projects

Type	Project	MU Score	TU Score	ITM Score
Related-technology and existing-market	Serevent	1	2	7
	Augmentin	2	2	7
	Tenormin	3	2	7
	Diprivan	3	2	6
Unrelated-technology and new-market	Zantac	4	2	2
	Eminase	6	4	0
	Lamictal	5	3	1
New-market and new-technology	Imigran	4	5	2
	Tagamet	3	5	2
	Zoladex	5	3	3
	Zovirax	4	3	2
	Retrovir	4	4	3

Notes: MU stands for Market Uncertainty, TU for Technological Uncertainty and ITMS for Internal Technological and Marketing Strength.

It has been found earlier in 9.2.1 that the R&D/marketing interface was present in at least two and at most five dimensions in the twelve innovation projects. In addition, it has also been revealed that the presence and the effectiveness of the R&D/marketing interface in the twelve projects varied considerably in the five dimensions. In this section, it is attempted to explain the underlying reasons for this variation guided by the theoretical proposition.

By comparing the types of the projects illustrated in Table 9.2 and the effectiveness of the R&D/marketing interface in Table 9.1, it is revealed that:

- (a) all the three projects that have the largest number of highly effective interface dimensions, i.e. Serevent, Augmentin and Diprivan, belong to the "related-technology and existing-market" type of projects;
- (b) relatively few effective interface dimensions were present in the Tagamet, Lamictal, Zovirax, Zoladex, Retrovir and Eminase projects which belong to the "new- or unrelated-technology and new-market" type of project;
- (c) all the innovation projects that had a highly effective interface in the operational dimension belong to the "related-technology and existing-market" type of project.

These findings have generally supported the research proposition of the direct environmental influence upon the interface effectiveness in the five dimensions. Moreover the findings have further elaborated the research proposition that the interface role is influenced by the market and technological environment in such ways that

- (a) the overall R&D/marketing interface tends to be more effective in a "related-technology and existing-market" type of projects than in a "new- or unrelated-technology and new-market" type of project;
- (b) the overall R&D/marketing interface tends to be more difficult to achieve in the "new- or unrelated-technology and new-market" type of project;
- (c) the R&D/marketing interface in the area of market research is more effective when the market and technology are not new. The lack of appropriate market research techniques in a new market and new technology situation still remains a problem.

It is noticed that the above findings do not provide significant association between any individual dimension of the interface (except for the operational dimension) and the type of project. This implies that an effective overall interface in a certain type of project may be achieved by a combination of different rather than fixed interface dimensions.

On the other hand, a relatively obscured area is found covering the Zantac, Imigran and Tenormin projects, where the findings do not exactly apply. Despite that the overall interface effectiveness in the Tenormin project, which is categorized as a "related-technology and existing-market" type of project, is higher than most of the "new- or unrelated-technology and new-market" type of projects, its place is below both the Zantac and the Imigran projects which are categorized as the "new- or unrelated-technology and new-market" type of project.

In addition, earlier in 9.2.1 a weak product design link in the R&D/marketing interface, which has been suggested by the existing research, is confirmed. However this weak product link was suggested to be caused by the new-market and new-technology situation confronting a new product development. However, comparing Table 9.1 with Table 9.2, it is revealed that not only the "new- or unrelated-technology and new-market" type of project suffers from a weak product design link, some of the "related-technology and existing-market" type of projects including the Augmentin and Diprivan projects were also caught up with the same problem. Thus, the above findings suggest that although the market and technological environment is a major factor affecting the effectiveness of the R&D/marketing interface, it is not the sole influence.

9.2.3 The Organizational Influence Upon the R&D/Marketing Interface

Numerous studies in the organizational literature have examined the influence of organizational factors such as personal motivation, resource dependence and conflict upon the R&D/marketing relationship (Ruekert & Walker, 1987). However, most of the research in this field is limited to the internal organizational environment, and the influence of the external environment is not considered. In the current research, the influence of such organizational factors as coordination mechanisms, communication flows, conflict and the relative influence of functional departments are examined in the context of the external market and technological environment. Consequently the following research question is posed

Q3: How and to what extent does the negotiated exchange process between R&D and marketing affect the fulfilment of the interface role?

Meanwhile proposition P3 has been developed in the framework to address question Q3:

P3: the extent to which the interface role is fulfilled depends on the appropriateness of the coordination mechanism, the effectiveness of communication, the relative influence of R&D and marketing and the type of interface conflict.

In order to test this proposition against the case studies evidence, we first summarize the status of this exchange process observed in the twelve drug innovation case studies in Table 9.3.

Table 9.3 The Status of the R&D/Marketing Interface Exchange Process

Drug	ICM	ICF	IC	RIRM	ST
Serevent	RC, PDC & PT	VF & E	Smooth	RI-MD	VE
Zantac	CI, PDC & PT	VF & HE	LMA	RD-CD-MD	ER
Augmentin	CI & PT	VF	DM & DR	MD-CC-RD	VE
Retrovir	CI & PT	VF & E	None	CD-PD	ER
Imigran	CI, PDC & PT	F & RE	LCM	RD-CC	RL
Diprivan	PDC, MSP & PT	RE	DM	MD-CC-RD	VE
Tenormin	PT	RE	LMA	RD-MD	ER
Zoladex	MSP & PT	F (within project team)	DM	CC-RD	RL
Lamictal	PT	E (within project team) CB (at top level)	None	RD-CC	RL
Tagamet	DS & ad-hoc	F (within subsidiary)	LCM & RBM	RD-CC	Late
Eminase	PT	NF	MDS & LCM	RD	Late
Zovirax	PT	RE (within project team) CB (at top level)	LCM & RBM	RD	Late

Where: CB - Communication Barrier
 CC - Close Corporation
 CD - Corporate management Driven
 CI - Corporate management Involvement
 DM - Dissatisfaction of Marketing toward R&D's time scale
 DR - Dissatisfaction of R&D toward marketing's time scale
 E - Effective
 ER - Early
 F - Frequent
 HE - Highly Effective
 IC - Interface Conflict
 ICF - Interface Communication Flow
 ICM - Interface Coordination Mechanism
 LCM - Lack of Credibility of Marketing's information
 LMA - Lack of Mutual Appreciation
 MD - Marketing Driven
 MDS - Mutual Distrust
 MSP- Marketing Strategic Plan
 NF - Not Frequent
 PDC - Product Development Committee
 PD - Production Driven
 PT - Project Team
 RBM - Research people has Biased view of Marketing's role
 RD - Research Driven
 RC - Research Committee
 RE - Relatively Effective
 RIRM - Relative Influence of R&D and Marketing
 RL - Relatively Late
 ST - Starting Time
 VE - Very Early
 VF - Very Frequent

The place of a project in Table 9.3 is determined according to the effectiveness of the coordination mechanism and the interface communication flows (ICF) in the project. The more effective a project is, the higher up it is in the table.

The empirical results in Table 9.3 illustrate a difference in the R&D/marketing interface pattern in the twelve drug innovation projects as far as the four organizational constructs are concerned. The next step is to examine whether such a difference has affected the fulfilment or the effectiveness of the R&D/marketing interface role in the five dimensions. Here it is important to distinguish the effect of the environmental constructs, which has been investigated in 9.2.2, with the effect of the organizational constructs upon the interface effectiveness.

It is found in Table 9.3 that there existed six types of conflict between R&D and marketing in drug innovation. They include

- (a) the dissatisfaction of marketing staff towards R&D's time scale;
- (b) the dissatisfaction of R&D staff toward marketing's time scale;
- (c) the lack of mutual appreciation between R&D and marketing;
- (d) the lack of credibility of marketing information perceived by R&D;
- (e) the R&D's biased view of marketing; and
- (f) the mutual distrust between R&D and marketing.

Here, an attempt is made to answer the question raised at the end of 9.2.2 with regard to the higher interface effectiveness of the Zantac and Imigran projects, comparing with the Tenormin project. Table 9.3 reveals that although the two projects Zantac and Imigran do not belong to the "related-technology and existing-market" type, both the coordination mechanism and the communication flows in these projects were more effective while other organizational factors remained relatively consistent.

A earlier observation in 9.2.2 on a weak product design link in the projects which do not belong to "new-market and new-technology" types of project is explained also. Empirical findings in Table 9.3 reveal that both the Augmentin and Diprivan projects which were caught up with this problem had experienced a interface conflict resulting from a marketing's dissatisfaction of R&D's prolonged time scale and a sudden change in the relative influence of the interface from marketing to R&D at later stage of development.

The above findings confirm that the environmental factors and the organizational factors have a combined effect upon the R&D/marketing interface. Further implications of the above findings are provided in Section 9.3.

In addition, a relationship between the organizational constructs and the environmental constructs is revealed by comparing Table 9.1, Table 9.2 and Table 9.3 together. It is found that

- (a) there existed a various degree of power shifting between corporate management, R&D Department and Marketing Department in a majority of projects during the innovation process. Moreover, six out of eight of the "new- or unrelated-technology and new-market" type of projects were research-driven or mainly research-driven;
- (b) there existed an association between the type of conflict and the type of project. In particular, the lack of credibility of marketing information (LCM) and research people's biased view of marketing's role (RBM) tend to be associated with the "new- or unrelated-technology and new-market" type of project, while the dissatisfaction of each other's time scale (DM and/or DR) escalates in the projects challenged by contingent technical problems.

9.2.4 The Performance of The Drug Innovation Projects

The measurements for the drug innovation performance have been developed in Chapter 3, "The Research Theoretical Framework" with reference to the existing literature. With regard to the situations in the pharmaceutical industry, three measures are used to evaluate the drug innovation performance. They are (a) the absolute and/or the percentage of the new drug sales; (b) the development speed, which measures both the time resources needed to obtain marketable outputs and the firm's ability in fast-tracking important innovation projects; and (c) the innovative level of the drug innovation, which measures both the technical resources needed to obtain marketable outputs and the firm's ability in producing innovation output of high importance. The performance of the twelve drug innovation projects is shown in Table 9.4.

Table 9.4 The Performance of the Drug Innovations

Company	Drug	Innovative Level	Development Speed	Sales
Glaxo	Zantac	Moderate/high	Very Fast	Very High
	Imigran	Very high	Relatively Fast	High
	Serevent	High	Fast	High
SmithKline Beecham	Tagamet	Very high	Relatively Fast	Very high
	Augmentin	Moderate/high	Very Fast	High
	Eminase	High	Relatively Fast	Low
ICI Pharmaceuticals	Tenormin	Moderate/high	Slow	Very High
	Diprivan	Moderate/high	Very Slow	High
	Zoladex	High	Very Slow	Low
Wellcome	Zovirax	Very high	Very Slow	High
	Retrovir	Very high	Very Fast	High
	Lamictal	Moderate/high	Very slow	Low

Table 9.4 reveals that, in spite of their high or moderately high innovative levels, the Eminase, Zoladex and Lamictal projects were commercially unsuccessful. This implies that the novelty of a new drug is not sufficient for new product success.

Meanwhile, Table 9.4 indicates that although there were only three out of the twelve drug innovation projects studied achieved very fast or fast development speed, a much higher percentage of the projects, i.e. three out of four of the drug innovation projects studied (including the three fast drug innovation projects) achieved commercial success. This suggests that fast development speed is important for successful innovation. However, it may not be essential in all cases.

Next comparing Table 9.4 with Table 1, it is found that all the three unsuccessful drug innovation projects, i.e. Eminase, Zoladex and Lamictal had a weak R&D/marketing interface presence. This reveals that a weak R&D/marketing interface is associated with poor innovation performance.

In addition, comparing with Table 9.4 and Table 9.2, it is revealed that although both the "unrelated-technology and new-market" type and the "new-technology and new-market" type of project have relatively weak interface presence, the former has a higher failure rate. Further discussion on this finding is carried out in Section 9.3.

Finally, comparing Table 9.4 with Table 9.3 it is revealed that both marketing-driven and research-driven projects can lead to successful product innovation. However, they are likely to be suitable for different technological and market situations.

9.3 THEORETICAL AND MANAGERIAL IMPLICATIONS OF THE CURRENT EMPIRICAL FINDINGS

The confirmation of the role of the R&D/marketing interface in the five dimensions, i.e. the corporate strategic dimension, the corporate technical dimension, the product strategic dimension, the product technical dimension and the operational dimension, has provided the future research in the R&D/marketing interface field with a crucial link to several academic areas, including the strategic management, marketing and organization studies. Meanwhile, the definition of the five dimensions has a practical value in helping managers identify more precisely their responsibilities and detect more accurately the weaker interface dimensions that need to be strengthened.

In addition, on the basis of the theoretical framework the current research is able to offer a higher level explanation of the tendencies and variations regarding the R&D/marketing interface in drug innovation. Moreover, the research framework which has not been constrained to the pharmaceutical industry has provided the opportunity for future research in this field to study the R&D/marketing interface in other industries. In this section, a wider discussion regarding the theoretical and managerial implications of the current research is carried out on the basis of the empirical findings.

9.3.1 The Combined Effect of the Environment and the Organization on the R&D/Marketing Interface

The empirical findings of the current research have revealed that the variation in the effectiveness of the R&D/marketing interface in the five dimensions is related to the market and technological environment. Thus, the interface tends to be more effective in a "related-technology and existing-market" type of project, where both market and technological uncertainties are relatively low and internal expertise to carry out the innovation task is relatively high than in a "new- or unrelated-technology and new-market" type of project.

However, the market and technological environment of an innovation project alone does not determine the effectiveness of the R&D/marketing interface. The status of the negotiated exchange process within the organization also has an important impact upon the interface effectiveness. This finding implies that managers need to evaluate carefully the market and technological environment of an innovation project with reference to the method used in the current research, and for those projects that involve high environmental uncertainty, effective coordination mechanism, communication flows and conflict resolution devices should be strongly emphasized.

9.3.2 The Different Desired Level of the R&D/marketing Interface in Different Projects

The findings of the current research indicate that the desired level of the R&D/marketing interface need is not identical for all the projects. In the previous section, it has been revealed that although both the "unrelated-technology and new-market" type of project and the "new-technology and new-market" type of project had relatively weak interface presence, the former had a higher failure rate. This finding indicates that the desired interface level for the "unrelated-technology and new-market" type of project is higher than that for the "new-technology and new-market" type of project. The reason is that although the technological uncertainty in the "new-technology and new-market" type of project is slightly higher than that in the "unrelated-technology and new-market" type of project, the latter usually encounters intensive competition

which leads to a higher market uncertainty. A highly competitive environment requires the R&D/marketing interface to be highly effective so that a timely product innovation which fills the gap between the existing products and the customer needs and is targeted to a profitable segment can be introduced. On the other hand, it is noticeable that this competitive situation is similar to that in a "related-technology and existing market" type of project. However, being in an existing market and with much higher internal technological and marketing expertise, both the desired interface level and the difficulty in achieving this level are lower in the latter type of project. This has an important managerial implication. When the commercial attractiveness of two projects are comparable, a "related-technology and existing-market" type of project should be favoured against a "new-technology and new-market" type, which however may be favoured against an "unrelated-technology and new-market" type of project, as far as project selection is concerned.

9.3.3 The Effect of the External Environment on the Negotiated Exchange Process Within Organization

The empirical findings of the current research have demonstrated a direct relationship between the organizational constructs and the environmental constructs. The finding that the "new- or unrelated-technology and new-market" type of project was mainly research-driven provided positive evidence for the existing theory that the department which possesses the most appropriate skills and information to cope with critical uncertainty comes to have stronger influence.

In addition, the finding regarding the association between certain types of conflict and types of project has an important implication on the organization theory regarding the source of inter-group conflict. This finding implies that the source of inter-group conflict is not restricted to internal organizational factors such as different personalities, background, experiences and group interests, but is also related to the external market and technological environment. Thus, it is useful for managers to anticipate the likely occurrence of the types of interface conflict and to develop appropriate conflict resolution devices.

9.3.4 Unexpected Findings From the Current Research

(1) The Serious Effect of Contingent Technical Problems

In the research theoretical framework, three facets of the technological uncertainty construct were defined in relation to the pharmaceutical industry. They are (a) Cause of Disease, which largely determines the nature of the drug innovation project, (b) Mode of Action, which reflects the newness of the technology applied in the drug research and development, and (c) Side Effect, which reflects the product complexity of a new drug.

However, it is revealed in the current research that the contingent technical problems which occurred during the later stage of the innovation process, such as moisture sensitivity, poor water solubility and instability of a new compound, had substantially increased the drug's technical complexity, and thus had a serious effect on the effectiveness of the R&D/marketing interface and on the innovation performance.

The findings show that in general the R&D/marketing interface level in terms of the effectiveness and the frequency increases when an innovation project was approaching the market. However a decreased interface level in some projects, including Augmentin, Diprivan and Zoladex, was revealed, resulting from the contingent technical problems encountered by the project teams at the later stage. Although the vitality of the effect of these technical problems upon the interface varied in different projects, the occurrence of such problems at the later stage had the following three negative effects:

- (a) a shift of the interface emphasis to technical rather than commercial at pre-launch stage and sometimes an exclusion of marketing influence;
- (b) a rise in the uncertainty of the product's availability to the market;
- (c) an increase in the risk of conflict between R&D and marketing.

The finding implies that managers should at the early planning stage assess carefully the possibility of encountering serious technical problems later in the process and their impact upon the project. Therefore, necessary precautionary measures can be prepared in advance.

(2) The Competitive Advantage of the Research Expertise Over the Development Speed

In the previous section, a positive association between development speed and corporate management commitment has been confirmed. However, the findings have also revealed that although the development speed was an important factor for innovation success, it may not be the most important factor in some cases. It is found that when the technological uncertainty is extremely high in a drug research area, a company's strong research expertise and technical competence in this area provided a more important competitive advantage which sometimes pre-empted the possibility of any competitive entry as demonstrated in the Zovirax case.

On the other hand, although fast development speed does bring many advantages to the drug company such as a strong corporate image, a leading market position and a first-line treatment acting as an effective barrier to entry as illustrated by the Retrovir project, it has to be balanced with the development risk (the risk of the new drug causing high reverse effect even death or failing to fulfil the fundamental technical requirements). This development risk is negatively associated with the development time, since the reduction of such risk requires a certain amount of market information. The on-going controversy about Retrovirs' efficacy and side effect has demonstrated the need to keep this crucial balance.

(3) An Association Between the Starting Time of the R&D/Marketing Interface and the Types of the Projects

In the previous section, it is found that the interface starting time is associated with the type of the project. All the "related-technology and existing market" type of projects had a very early or early interface starting time. The reason is that in this type of project, firms have relatively good knowledge and expertise in both technology and market, which make the exchange of technical and

market information between these two parties easier. Moreover, because this type of innovation project is incremental, it can be viewed as a major post market development from an earlier product, such as Augmentin from Amoxil and Serevent from Ventolin. Thus, being a continuous product development, the R&D/marketing interface is also likely to be a continuous one as well.

Nevertheless, it is revealed that although the two projects, Zantac and Retrovir, do not belong to the "related-technology and existing market" type of project, they also had a early starting time, resulting from a very strong corporate management involvement. This indicates that strong corporate management involvement encourages not only effective communication but also an early interface.

9.4 SUMMARY

In this chapter, the empirical findings in relation to each of the three research questions and propositions are analyzed following a brief summary of the limitations of the existing studies. Next a general discussion on the theoretical and managerial implications of the empirical findings is provided, where several unexpected findings are generated.

The case studies' results have generally supported and further elaborated the research propositions, which have been purposely developed to remain at a relatively abstract level in Chapter 3 "The Research Theoretical Framework". The reasons for this have been explained in Chapter 2 "The Research Methodology".

The results have revealed that the role of the R&D/marketing interface in drug innovation covers the five dimensions. They are (a) the corporate strategic dimension, (b) the corporate technical dimension, (c) the product strategic dimension, (d) the product technical dimension and (e) the operational dimension.

However, the effectiveness of the R&D/marketing interface in the five dimensions varies considerably. For example, it is found that the R&D/marketing interface is still relatively weak in the corporate technical

dimension and the product technical dimension. The research reveals that the variation is influenced by the market and technological environment in such ways that (a) the R&D/marketing interface tends to be most effective in a "related-technology and existing-market" type of projects and (b) the R&D/marketing interface tends to be more difficult to achieve in the "new- or unrelated-technology and new-market" types of projects.

Moreover, the results indicate that the desired level of the interface is not identical for all the innovation projects. It is higher for a "unrelated-technology and new-market" type of project than for a "new-technology and market" type of project. In addition, an overall effective R&D/marketing interface in a certain type of project can be achieved by a combination of different rather than fixed interface dimensions.

Nevertheless, although the market and technological environment is a major factor affecting the effectiveness of the R&D/marketing interface, it is not the sole influence. The environmental factors and the organizational factors have a combined effect upon the R&D/marketing interface. A weak R&D/marketing interface is associated with poor drug innovation performance.

Meanwhile it is found that both the "marketing-driven" and "research-driven" projects can lead to successful product innovation. However, they are likely to be suitable for different technological and market situations. For instance, a "research-driven" project is likely to be associated with high technological uncertainty.

Several unexpected findings have been derived from the research. First, the research has revealed a new source responsible for a weak R&D/marketing design link. In the literature (Bonnet, 1986), it is proposed that the major areas of difficult in product dimension assessment are the extrapolation of customer requirements over the development period and the reconciliation of differing requirements from customers over the same period. This source of difficult has been confirmed in the current research, which is related to the operational dimension of the interface. However, the current research findings further suggest that the difficult in this interface dimension is not only caused by the market factors suggested in the literature, but also caused by the technical factors - the contingent technical problems. It is found that a contingent

technical problem occurred at the later stage of the innovation process can substantially increase the drug's technical complexity, thus seriously affecting the effectiveness of the R&D/marketing interface, especially in the product technical dimension. The effects upon the interface can be summarized as

- (a) a shift of the interface emphasis to technical rather than commercial at pre-launch stage and sometimes an exclusion of marketing influence;
- (b) a rise in the uncertainty of the product's availability to the market;
- (c) an increase in the risk of conflict between R&D and marketing.

Secondly, the results have revealed that fast development speed is an important but not an essential factor for every successful innovation project and a balance between development speed and development risk is more crucial. Meanwhile, it is found that a strong corporate management involvement encourages not only effective communication but also an early interface. Finally, a lack of the strategic R&D/marketing interface is found in companies when dealing with drug's regulatory issues.

The current research findings have several important managerial implications. The definition of the five interface dimensions can help managers identify more precisely their responsibilities and detect more accurately the weaker interface dimensions that need to be strengthened.

In addition, the finding that the environment and the organizational factors have a combined effect upon the R&D/marketing interface effectiveness implies that managers need to evaluate carefully the market and technological environment of an innovation project and to take certain organizational measures. The environmental constructs identified in the research framework and the checklists method used to measure these constructs can help the managers for this purpose.

The finding regarding the association between the type of conflict and the type of project implies that the source of inter-group conflict is not restricted to internal organizational factors, such as different personalities and background,

but it is also related to the external market and technological environment. Thus, managers should make effort to anticipate the likelihood of their occurrence and to develop appropriate conflict resolution devices.

Finally, the current research has certain implications for the future research. The definition of the five dimensions of the R&D/marketing interface will provide the future research in this field with a crucial link to several academic areas. The research framework which has not been constrained to the pharmaceutical industry will provide the future research with the opportunity to study the R&D/marketing interface in other industries.

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APPENDIX 1

INTERVIEWS OF THE PILOT STUDY

Name	Position	Company	Date
C. Davies	Marketing Manager	John-Brown Automation	24/3/9
P. Shipton	Technical Manager	Courtaulds	18/7/90
G. Noon	Vice President	Bristol-Myers (UK)	20/7/90
T. Howard	Business Director	Courtaulds Special Chemicals	25/7/90
S. Tomschey	Subsystem Manager	GPT Telecom	12/8/90
R. Drucker	Director	UpJohn (Europe)	5/9/90
Z. Li	Research Associate	Biosym Technologies	7/4/90
L. Fang	Engineer	COSA Crosfield Graphics Co. Ltd.	5/9/90
G. France	Technical Manager	SmithKline Beecham	4/3/90

APPENDIX 2

INTERVIEWS OF THE FOUR CASE STUDIES

Company	Name	Position	Type	Date
Glaxo	D. Richards	Former Medical Director of Glaxo Group Research	Tele.	8/3/91
	B. Railton	International Marketing Manager for Zantac	Tele.	24/6/91
	C. Towler	Director of Development Planning, Glaxo Group Research	Face	6/3/91
			Face	4/7/91
			Tele.	3/9/91
	R. Hotston,	Research Manager, Glaxo Group Research	Tele.	7/3/91
	C. Piggin	Clinical Trials Planner, Glaxo Group Research	Tele.	17/7/91
	M. Whiteman	Former Product Manager for Zantac	Face	3/8/91
	D, Satter-thwaite	International Marketing Manager for Imigran	Tele.	24/6/91
	M, Owen	Director, Business Strategy,	Face.	23/5/91
			Tele.	28/6/91
	R. Coleman	Member of the Serevent Research Team	Tele.	24/6/91
	A, Pilgrim	International Marketing Manager for Serevent	Tele.	26/6/91
SmithKline Beecham	G, Leonard	Manager of Pharm. Development Dept. I	Face.	18/5/91
	J, Sime	Senior Vice President of Worldwide Strategic Product Development	Face.	18/5/91
	A, Clancy,	Marketing Director for Anti-infective Products	Face.	18/5/91
	S. Corkill	Former Marketing Manager for Anti-infective Products	Face.	21/5/91
	P, Crowley	Manager of Pharm. Development Dept. II	Face.	25/5/91
	D, Fake	Head of Post Product Development Dept.	Face.	16/3/91
			Face.	25/5/91
	G, France	Former Manager of Pharm. Dept. II	Face.	16/3/91
	M, Whiteman	Senior Section Head, Pharm. Development Dept. II	Face.	25/5/91
	P, Martin	Marketing Director for CNS Products	Face.	18/5/91

Appendix 2 (Continued)

Company	Name	Position	Type	Date
ICI Pharma ceuticals	M, Joseph	International Planning Manager for Cardio- vascular products, Product Strategy Dept.	Face.	14/3/91
	G, Costello	Manager of Pharm. Development Dept. for CNS products	Face.	10/9/91
	A, Pleuvry	Senior International Planning Manager for CNS Products, Product Strategy Department	Tele.	21/5/91
	M, Cross	Manager of Pharm. Development Dept. for Anti-infective products	Tele.	28/5/91
	S, Corkill	Associate Inter. Marketing Manager for Anti-infective products	Face.	14/3/91
	B, Hinze	Marketing Manager, ICI Pharmaceuticals	Face.	10/9/91
	J, Kelly	Marketing Manager, ICI Pharmaceuticals	Face.	14/3/91
	K, Bilyard	Manager of Product Development	Face.	14/3/91
	D. Nelson	Manager of ICI Pharm. International	Face.	14/3/91
	G.Heselwood	Planning Manager	Face.	30/6/92
Wellcome	N, Heightman	Strategic Business Manager for Antiviral Products	Face.	3/8/91
	T, Leaford	Strategic Business Manager for Antiviral Products	Face.	3/8/91
	K, Pond	Head of Research in Anti-viral area	Face.	27/3/91
	D, Milton	Marketing Manager for Anti-cancer Products	Face.	3/8/91
	P. Jeffery	Product Manager, Strategic Marketing	Face.	27/3/91
	R, White	Manager of Project Services, Unite of RD&M	Face.	3/8/91
	R, Mills	Technical Adviser, Marketing Operation Dept.	Face.	3/8/91
	S, Self	Project manager, Unite of Research, Development & Medical	Face.	27/3/91
Total number of interviewees				37

APPENDIX 3
COVER LETTER FOR THE INTERVIEWS

MARKETING STRATEGIC MANAGEMENT GROUP (MSM), WARWICK
BUSINESS SCHOOL
COVENTRY CV4 7AL

15th May, 1991

To Whom It May Concern

This is to introduce Mrs Qing Wang, a qualified individual with extensive working experience and academic knowledge in the field of technology-based industry. Mrs Wang is now doing a doctoral research on the pharmaceutical industry R&D/marketing interface. She will undertake a series of four case studies based on the major UK pharmaceutical companies.

Ultimately, by means of this case study approach, it is hoped to identify and document answers to such questions as: How and Why is the R&D/marketing interface managed in the new product development process in the UK pharmaceutical companies? How and Why do the degree and effectiveness of the R&D/marketing interface differ? What factors have been important for a strong R&D/marketing integration?

This letter is directed to the R&D managers, project managers, marketing managers as well as the heads of interfunctional organizations in the major UK pharmaceutical companies. We must ask your time, experience and patience to our interviewer. A draft of the case report based on your company will be sent to you for your valuable advices and final approval regarding confidentiality.

Your cooperation is most essential if the research, which concerns the major and most crucial issue in today's pharmaceutical companies, are to be successfully completed. On behalf of all members of the MSM group, I wish to express our gratitude for your assistance. Should you wish to be sent the final report and the thesis, our interviewer will be glad to make proper arrangements.

Again, thank you very much.

Yours sincerely

Mel Hirst

APPENDIX 4
OUTLINE OF THE RESEARCH AND
AREAS OF THE INTERVIEWS

The topic of this PhD research is "The R&D/Marketing Interface in Product Innovation in the UK Pharmaceutical Industry". In this research, we have selected four U.K. leading pharmaceutical firms for in-depth studies, which includes a total of twelve cases of new drug innovation.

Based on the research theoretical framework, the research is intended to understand the R&D/marketing interface process, and to explain the relationships between the interface, the market evolution and competitive condition and the technology. For this purpose, the research covers the entire life cycle of the drug development starting from the idea generation stage.

Your company has been selected for the in-depth study. Its three ethical pharmaceuticals, i.e. (names of the three drugs), are selected for the case study. The interviews are one of the important sources of data.

The interviews will cover the five areas of each specific drug innovation:

(1) the organizational structure: what were the structures of the company, the marketing department and the R&D department at the time the drugs were being developed? what was the coordination mechanism between the R&D and the marketing departments? how was the relationship between these two departments?

(2) the market: was it new to the company or established? what was the estimated market size? what was the customer's condition? (from idea generation stage to the post launch).

(3) the competitive pressure: how many competitors were in the market when the drug was initiated and later launched? what were their products? was your drug the first entrant?

(4) the technology: is the drug a scientific breakthrough? what is the innovative level of the drug? what was the drug's chemical structure and mechanism? how does the drug treat the disease?

(5) the R&D/marketing interface process: recall any activities and events of the R&D cooperation which contributed to the drug development either at the strategic level, the product level or the operational

level. For instance, did R&D/marketing cooperated in the generation of the new product idea and how?

The interviews are purely for the academic purpose. The data obtained from the interviews will be put into the PhD thesis. It will have restricted accessibility to the public. However, all the case study reports will be send to the company interviewed for final approval.

APPENDIX 5

THE LETTER ATTACHED TO ONE OF THE CASE STUDY REPORTS WHICH
WERE SEND BACK TO THE INDUSTRY FOR FINAL COMMENT

Liverpool John Moores University
School of Engineering and Technology Management

30/11/92.

19 JAN. 93

Dear Dr Chris Towler,

I am sending you the modified version of the Glaxo Case - Chapter 4 for your valuable advice. I would particularly like you to comment on the variables used to measure various conditions in the pharmaceutical industry (please refer to the attached information). Do you think they are viable for studying the industry? ~~and~~ have you used ^{or seen} any similar method for evaluating the industry environment before? In what way do you think this method can be improved?

Could you please pass this ^{case} report to the other people who have also participated in the research (their names have been written on the attached material). Comments are very much welcomed.

Please send the reply to my new address shown in the envelope.

Yours Sincerely

Qing Wang

APPENDIX 6 DRUG COMPANY R&D PRODUCTIVITY, 1980-1990

Company	Total New Sales ¹ in Mill.	Rank	Total R & D in Mill.	Rank	New Sales R & D	Rank
Glaxo						
Holdings	11829	1	2503	5	473%	1
Pfizer	9413	3	3028	2	311%	2
Squibb	4846	5	1853	9	261%	3
Merck&Co.	9689	2	4963	1	195%	4
Upjohn	5272	4	2739	4	192%	5
Schering-						
Plough	3287	7	2092	8	157%	6
Eli Lilly	3457	6	2935	3	117%	7
Warer-						
Lambert	1156	8	1793	10	65%	8
Bristol-						
Myers	1139	9	2326	6	49%	9
SmithKline						
Beecham	555	10	2162	7	26%	10
Syntex	205	11	1441	11	14%	11

Source: Financial World, January 24, 1989.

Note

1. Includes only sales from products approved after 1980.

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APPENDIX 7
ONE OF THE INTERVIEW TRANSCRIPTS

Telephone Interview with Dr. Towler (Director of Development Planning)

Qing: Can you tell me how do you coordinate skills, resources and information across two functions (R&D and Marketing) in Glaxo?

Towler: We have all sorts of communication, we have informal meetings and formal meetings. We have many different committees including development coordinating committee, product development committee. We have meetings for brainstorm.

Qing: Can you tell me how you generate a new product idea?

Towler: We are science-driven company, basic ideas come from R&D. We involve marketing people after we have come up with a new product idea. We design the drug and they define the market target for us.

Qing: You have a Research Management Committee. Who are involved in this committee?

Towler: This committee is run by research, marketing people are not involved. Marketing people only get involved after the compound gets into the full development stage.

Qing: Can I say that Marketing people is only getting important for the development of new product from full development stage, but they have started to work long before this stage to work with R&D to understand the product's scientific issue.

Towler: Yes, you are right. Especially in science-driven products, R&D has to educate the marketing people about the product.

Qing: You identified two types of projects, i.e. science-driven and market-pull. Can you describe the difference of communication in this two projects?

Towler: In science-driven projects, both marketing and R&D are finding their way forward. A lot of new research need to be done. They are some unexpected destruction. on the whole, we communication very well. One of the important factor for Glaxo's success is our communication. We have video conference, we have very good communication from very senior people to very low level.

Qing: Can you tell me about your interfirm alliences?

Towler: We have some cooperation with other companies. We don't normally ask other company to do research for us. There is only a exception in that we ask a company to do research for us because in that area they have very good research team and we have good marketing knowledge. The reason for us to allien with other companies is the

company don't like merger or aquisition. As a

Q: In fact, in many we have more science-driven products than market-pull products.

Qing: Marketing people think that the identification of science-driven projects and market-pull projects is only one in the early stage, when it gets to the later stage they have no difference. Do you agree?

Towler: No. I think these two types of projects are always quite different until the very end. Yes, when it gets to the later stage marketing people get more involved. There are two types of projects, but I wouldn't quantify it, because every project is a mix of both. Market-pull is always there in any project, more or less.

Qing: Just different percentage.

Towler: Yes

Qing: How is the communication between R&D and marketing in these two types of projects? Do R&D and marketing communicate and depend on each other more in the science-driven projects than in the market-pull projects?

Towler: I wouldn't say that, it depends on each individual, there are some projects which have very good communication and some haven't. I think may be in science-driven projects, R&D need to teach marketing people more about the technology of the product.

Qing: So it is just that the content of communication is different?

Towler: Yes.

Qing: Can you define again the science-driven project and the market-pull projects?

Towler: In science-driven project, the prediction of the effect of the new drug from animal to man are not clear, whereas in the market-pull project the pharmacology of the drug is clearer.



Pharma International

Ms Wang Qing
Warwick Business School
University of Warwick
Coventry
CV4 7AL

ICI Pharmaceuticals

Southbank
Alderley Park Macclesfield
Cheshire SK10 4TF
Telephone (0625) 582828
Telex 669095/669388 ICIP
Fax (0625) 586296

Your ref	Our ref	Direct line	Fax	Date
	DJNCH517	513089		15 June 1992

Dear Ms Wang

I would like to invite you to visit ICI Pharma International at Alderley Park on 30 June 1992 to discuss your Phd. thesis on the UK Pharmaceutical Industry, with Mr Glynn Heselwood and myself. I suggest you aim to arrive at 11 am, stay for lunch and leave sometime during the afternoon.

Please let me know if this is convenient for you, and whether you require any transport to meet you at the railway station.

Yours sincerely

D J NELSON
Manager
ICI Pharma International

c.c Mr J G Heselwood





Wellcome

Group Marketing
Langley Court Beckenham
Kent BR3 3BS

Tel: 081-658 2211 Telex: 23
Telefax: 081-658 5927

NH254/1p

16th July 1992

Mrs Q Wang
Warwick Business School
University of Warwick
Coventry CV4 7AL

Dear Mrs Wang,

Following our telephone conversation of 16th July I would just like to confirm the arrangements that I have put in hand.

We will expect you at our Beckenham Site between 10:30am and 11:00am on 3rd August. The discussion programme will cover the questions you have raised in your briefing note and involve myself and two or three other colleagues from The Wellcome Foundations organisation in Beckenham. I expect the programme to run approximately as follows:

10:30 - 12:30 N J Heightman
12:00 - Trish Leadford Strategic Business Manager
12:30 - 13:45 Lunch with N J Heightman and and Dr R Mills

14:00 Dr Ralph White - Project Services Unit of Research
Development and Medical

15:00 Dr R Mills - Technical Advisor Group Marketing *clinical*

16:00 - 17:00 Either Mr D Milton or Mr T Ravenscroft - Group Marketing *lab*

I am confident that between us we can contribute effectively to the subject of your thesis.

I look forward to meeting you on 3rd August.

Yours sincerely,

N J Heightman